



# Overview

- 1 Definition and A Little History
- 2 Near-Term Challenges (2020-2060)

- 3 Features of Modern Computing
- 4 Urban and Global Applications

- 5 Appendix A: Cyber-Physical Systems
- 6 Appendix B: Engineering Sensor Systems

Part 01

































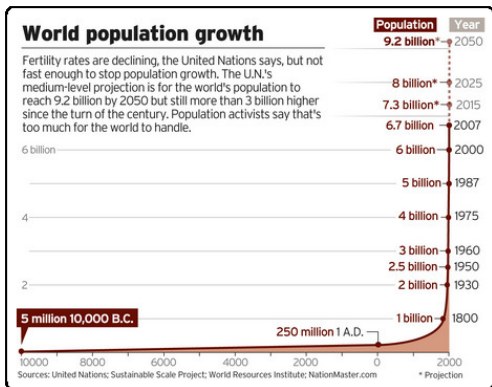








# Trends in World Population Growth



Increasing Population → Increased Demand on Limited Resources  
→ Increasing need for Improvements to System Efficiency.

# Urbanization and Sustainable Cities

## Urbanization in America:

- In 2010, 82 percent of Americans lived in cities.
- By 2050 it will be 90 percent.

## Cities are responsible for:

- Two thirds of the energy used,
- 60 percent of all water consumed, and
- 70 percent of all greenhouse gases produced worldwide.

## Sustainable cities (SIEMENS, Sustainable Cities, USA):

- Environmentally friendly infrastructures;
- Improved quality of life for residents;
- Good economics.



# Sustainable Urban Systems

Urban systems are like plants in your garden:

- Cities are defined by their **emergent properties** (e.g., beautiful flower  $\Leftrightarrow$  New York City Skyline).
- Cities **grow and flourish** based on societal and economic stimulus, and **fall into decay** when stimulus is absent.

But sustainability is a tough problem:

- Many of the world's large urban areas – so-called **mega-cities** – are in **poor economic shape**.

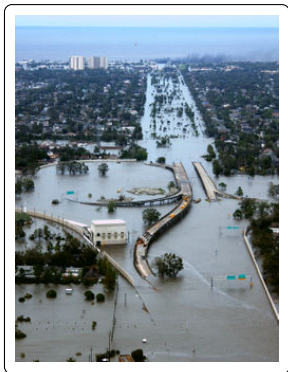
Cities are **system of systems**:

- Subsystems have a preference to **operate** as **independently as possible** from the other subsystems.
- Strategic **collaborations needed** to **limit cascading failures**.

# Resilience of Urban Infrastructure

## Example. Cascading Failures in Hurricane Katrina

- Hurricane Katrina caused a storm surge which, in turn, resulted in the failure of levees around New Orleans.
- This is a failure in the waterway network.
- A more conservative (expensive) design might have prevented this failure.
- But the failure didn't stop there.





# Dependencies Among Urban Networks

