PROJECT-BASED LEARNING IN ECE

J.-F. CHAMBERLAND & G. H. HUFF

GOALS AND RATIONAL

- Enhance college education by facilitating learning through **engineering projects**
- Foster leadership and **team work**, with division of labor, complementary tasks, discussion and integration
- Develop the ability to bridge theoretical concepts and practical tasks
- The **inquiry** and **research** is primary focus of the learning process (problem-based learning)

BRIEF COMPARISON

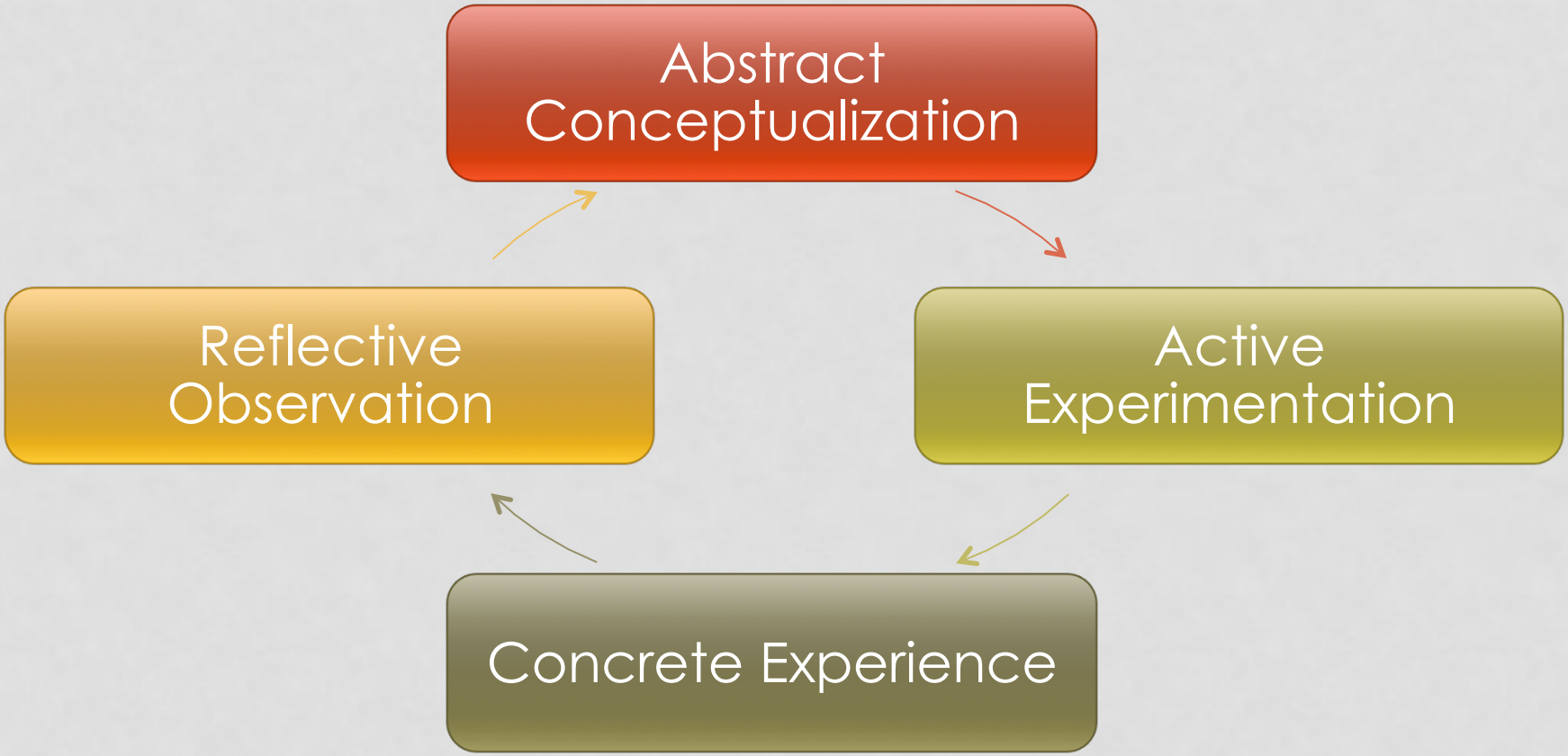
Traditional Approach

- ECE curricula are highly structured
- Programs emphasize the **acquisition of knowledge**
- Didactic lecturing
- Guide student to intended solution

Experiential Learning

- Devote time to develop **inquiring** and **creative minds**
- **Communication skills** are essential for engineers
- Open-ended projects demand **decision making** skills

EXPERIENTIAL LEARNING



COMPLEMENTING THE TRADITIONAL CLASSROOM

Develop many facets of engineering

Emphasize teamwork

Improve programming skills

Experience environment akin to workplace

ENVISIONED OUTCOMES

- Improve **transferable skills**
- Develop confidence and leadership
- Outlet for **creativity**
- Foster **critical thinking**
- Integrate different concepts
- Time management
- **Team** working
- Delivering **presentations**
- Leverage shared enthusiasm

PROJECT ATTRIBUTES

Identify a fundamental concept pertaining to ECE

Formulate a basic scientific question that can be tested

Establish a modular solution path to answer this question

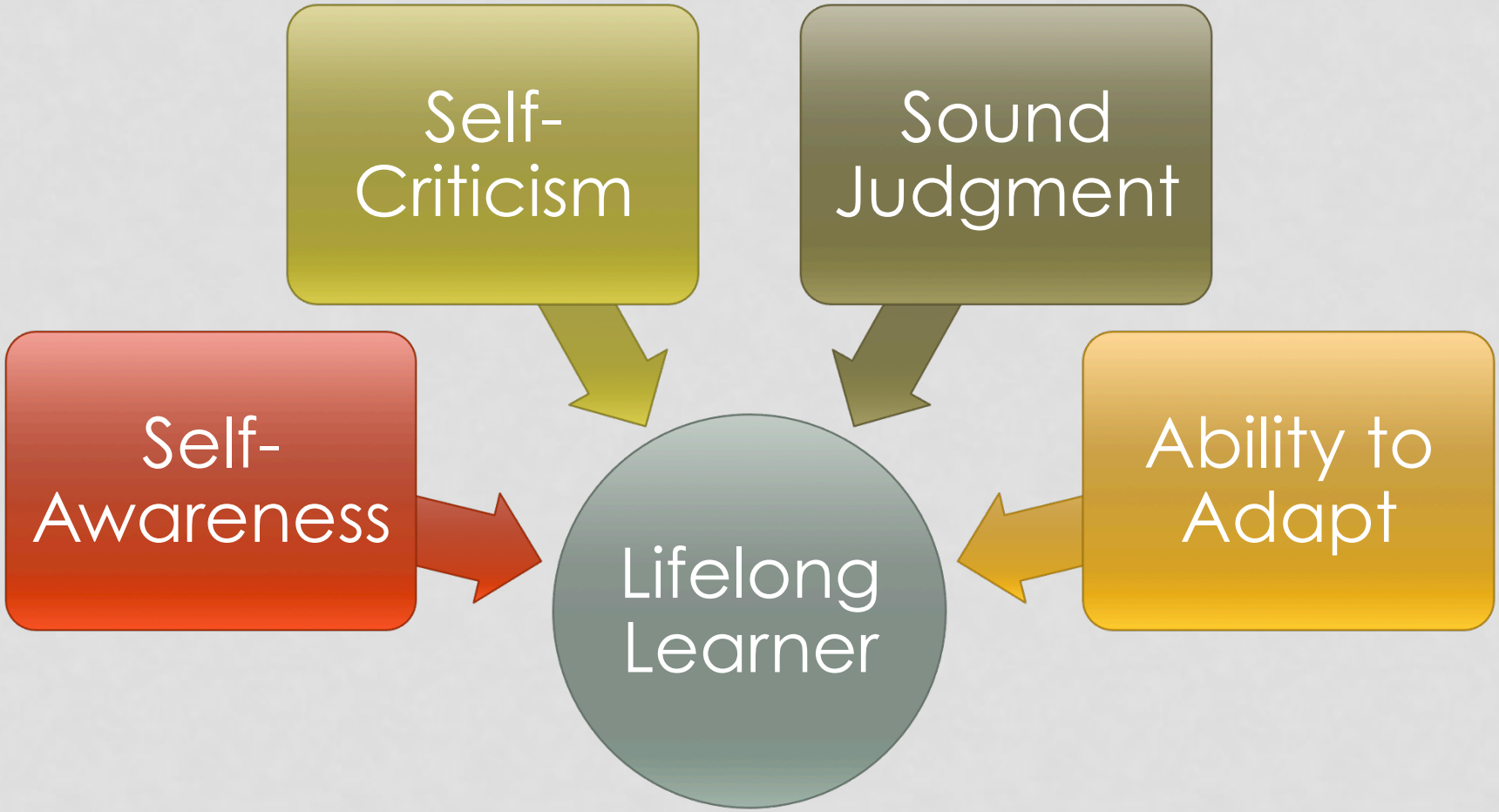
FAVORED FRAMEWORK

- Challenges arise, or are formulated, and solution path requires **problem-solving skills**
- Acquire competencies on incremental basis
- Apply knowledge to broad range of subject areas
- **Clear statement** of what is needed to complete an assignment
- Recommend reference material which may be useful for task
- Writing documents, making presentations and undertaking laboratory work

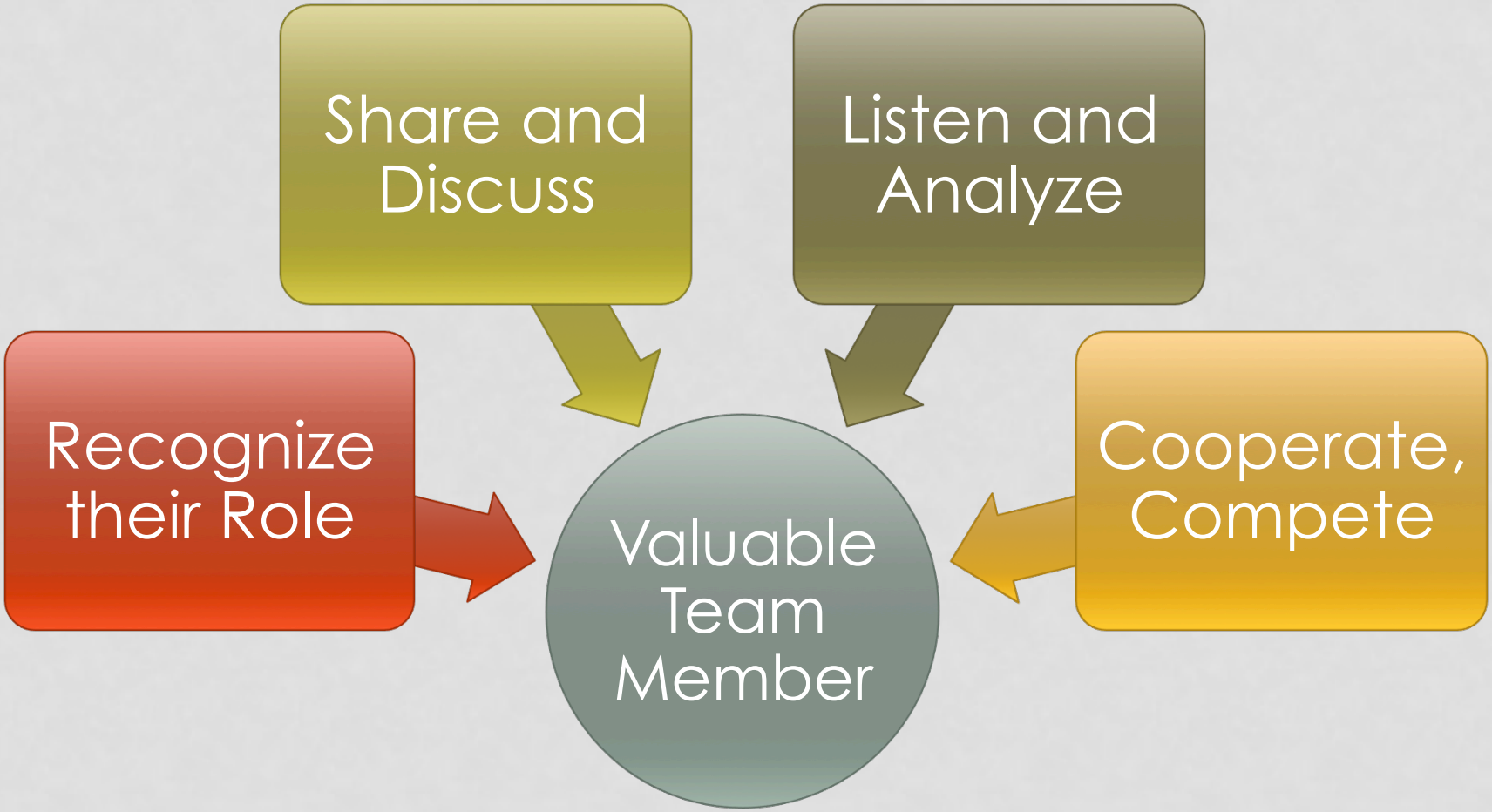
PROGRESSIVE APPROACH

- Starting with simple **modules** and precisely **defined tasks**
- Assessment based on **specific requirements** and inter-operability, e.g. test-driven design
- From individual, repeated assignments to **multi-faceted group** projects
- Challenges become increasingly **integrative** in scope
- Team size increases as semester advances

INDIVIDUAL BENEFITS AND PERSONAL REFLECTION



GROUP BENEFITS AND COMMUNICATION



ENVIRONMENT AND CULTURE

BUILDING A STRONG FOUNDATION

KEY ELEMENTS OF ONGOING EFFORT

- Broad Technical Background
- Effective Management Skills
- Mix of Research and Education
- Resources
- Enthusiasm of Students and Instructors

COMPLEMENTARY EXPERTISE

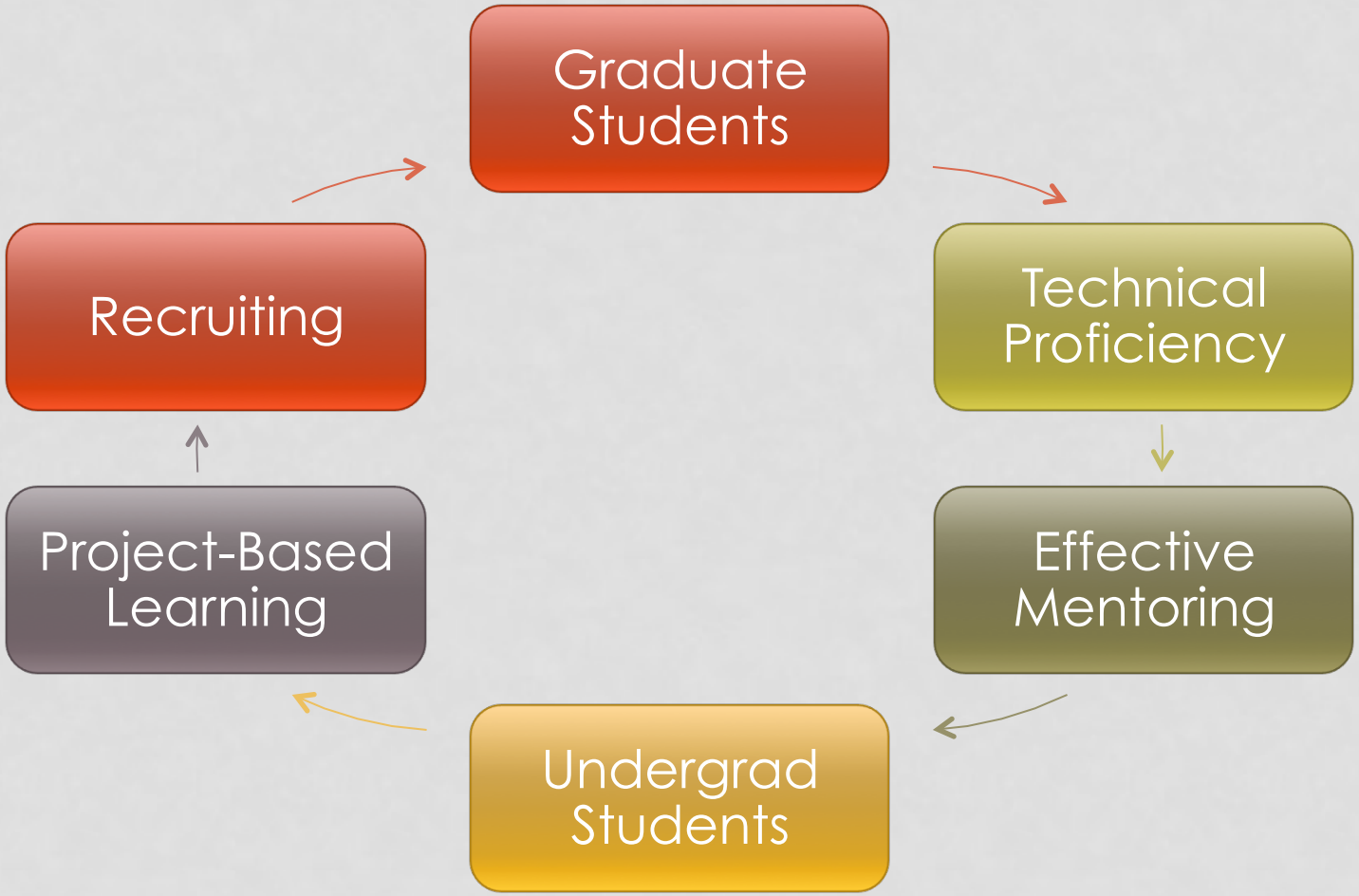
G. H. Huff

- **Antenna** Design
- High-Performance **Circuits**
- Adaptive Systems
- Tunable **Devices**
- Extensive **Managerial Experience**

J.-F. Chamberland

- Wireless **Communications**
- Statistical Signal Processing and **Inference**
- Decision and Control
- **Programming** Skills

TRANS-GENERATIONAL LEARNING



FACILITIES

Traditional Classroom

- Introduction of challenges
- Team discussions, conceptual designs
- Quizzes, test, peer grading, and reporting

Laboratory and Design Studio

- Huff Research Group (HRG) space
- Wireless Communication Laboratory (WCL)
- Anechoic chamber

Prototyping and Showcasing

- EIC; the great outdoors
- Engineering Showcase

CAPITAL EQUIPMENT

Fabrication and Testing

- Network analyzer
- Milling machine
- 3D printer

Video, Audio, and Editing Software

- Panasonic P2 framework
- Microphones and recording equipment
- Adobe Premiere Pro

Workstations and Design Software

- ANSYS HFSS, Mathematica, Mathworks Matlab, NI Labview, Solidworks, Microsoft Visio

RECURRING COSTS

Technological Revolution

- Micro-controllers: Arduino, Teensy, TI MSP 430
- Wired communications: I2C, USB, ethernet
- Commodity wireless: ZigBee, Bluetooth, Wi-Fi

Off-The-Shelf Sensing Solutions

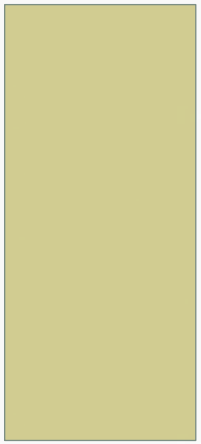
- Affordable I2C sensors
- Smartphone-enable projects

Printed Circuit Boards

- Electronic design automation EDA: KiCad
- Affordable PCB outsourcing
- Populated with components locally

PROJECT ARCHITECTURE: LEVERAGING TECHNOLOGIES

HARDWARE, SOFTWARE & PLATFORMS



DATA INFRASTRUCTURE

Software Logistics

- Apache server and Subversion repository
- User authentication and archiving
- Code sharing and peer testing

Inter-Networking

- Wireless access points to circumvent firewall issues
- Wi-Fi shields and Zigbee modules

Open Software

- GNU/Linux
- C++, Arduino IDE
- Android and Java

CASE STUDY: PROJECT ARCHITECTURE

Cloud Services

- Statistical Signal Processing & Learning
- Decision & Control

Data Management

- Android Phone & Mobile Platforms
- Databases

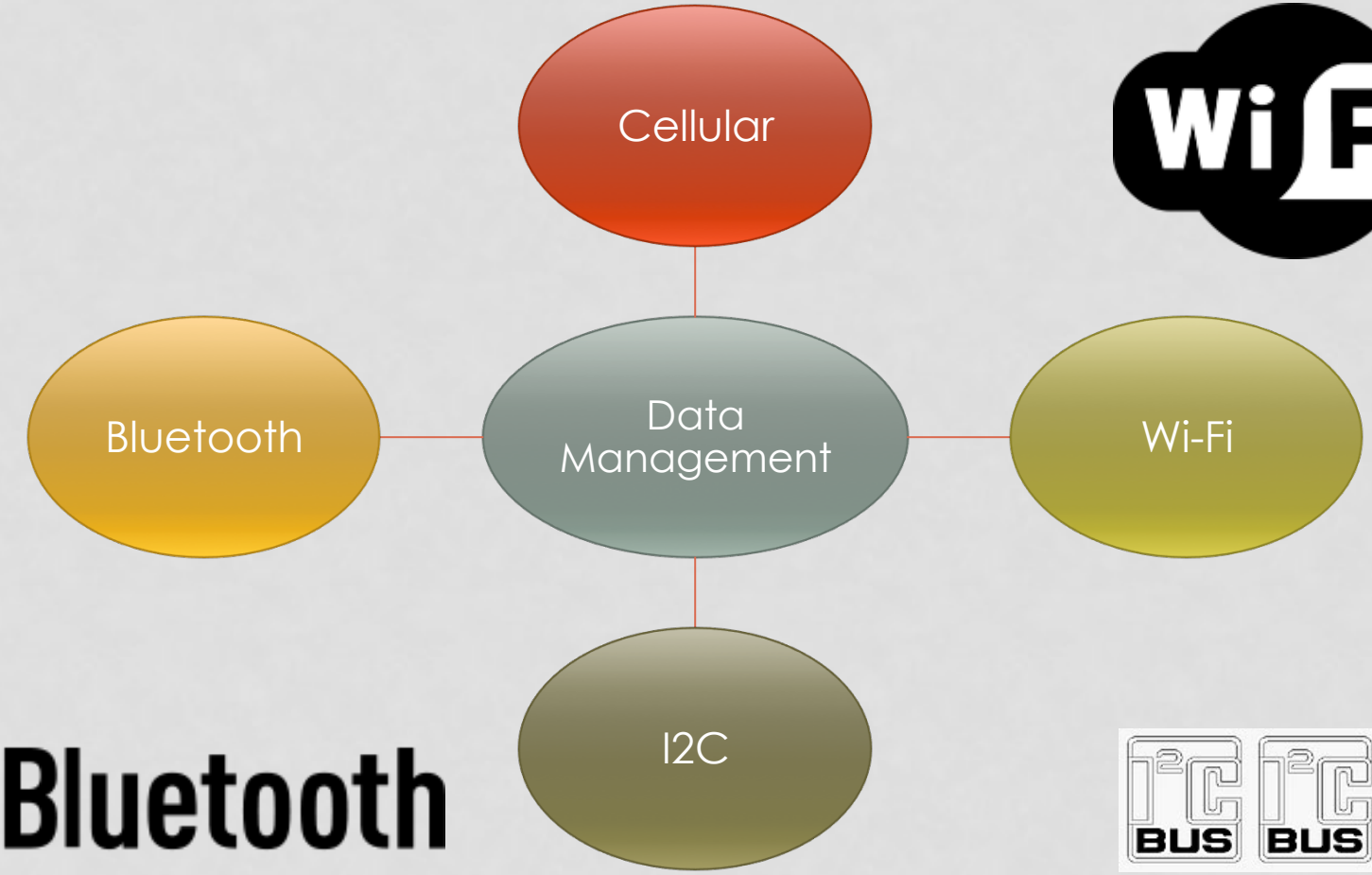
Physical World

- Sensors

CASE STUDY: PROJECT ARCHITECTURE

Virtual Server	Python	Linux, Apache, SQLite
Phones, Single-Board Computers	Java	Raspberry Pi, Atom Board, Intel NUC
Micro-Controllers	C/C++	Arduino, Teensy

CASE STUDY: COMMUNICATION INFRASTRUCTURE



CASE STUDY:
ECEN 489, ECEN 491, ENGR 489

2012-1=2013

489 – 2015

Programming Challenges

- Java
- Networked sum app
- Android sum app
- Networked Android app over Wi-Fi
- Android bluetooth socket programming
- Android to Arduino
- Zigbee with Xbee

Laboratory Projects

- Light sensing by node
- Network of sensor nodes
- Training & learning
- Proximity detection & estimation
- Relay data through Bluetooth
- RF source localization

RELEVANT PROJECTS

- **Reconfigurable Antenna Test-Bed** (APS 2013)
  - R. Brown, A. Couch, D. Grayson, N. Brennan
- **Pharandroid** (Ericsson 2012)
  - J. Jensen, K. Buchanan
- **DISH** (Senior Design)
  - U. C. Brindis, M. B. Coffman, N. J. Oborny, A. R. Osterhage
- **Autonomous Mobile Picocell Sensing** (AggiE)
  - A. Bennett, A. Couch, D. Kruzick, M. Price, J. Stanley

THANK YOU

J.-F. CHAMBERLAND & G. H. HUFF