Autonomous Systems Laboratory
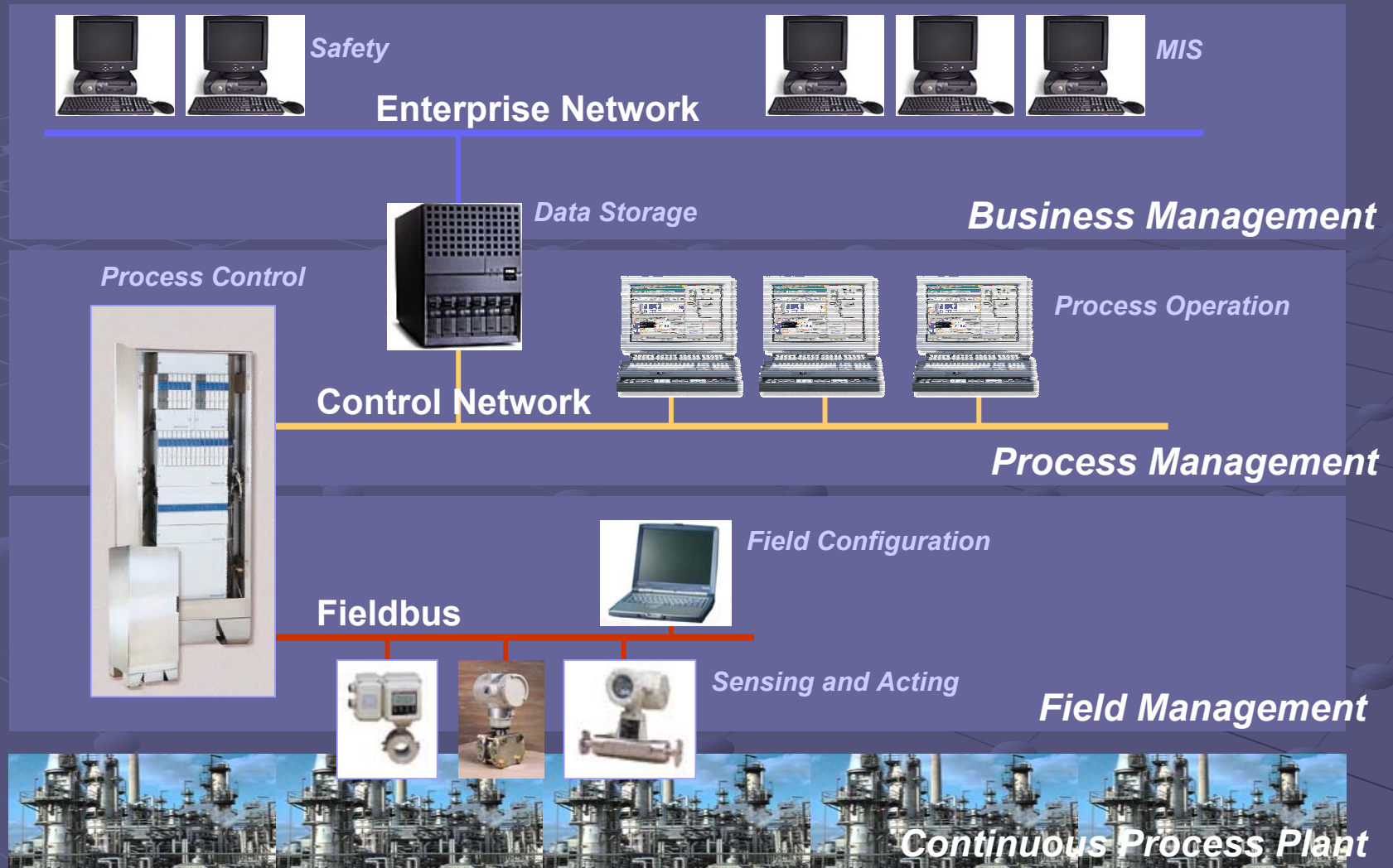
A Vision of Neuro-IT

Ricardo Sanz

Universidad Politécnica de Madrid
Department of Automatic Control

Contents

◆ The Control Stance

◆ Roadmap Assessment

◆ Comments and synergies in Challenges

Plant-wide Control

Safety

MIS

Enterprise Network

Data Storage

Business Management

Process Control

Process Operation

Control Network

Process Management

Field Configuration

Fieldbus

Sensing and Acting

Field Management

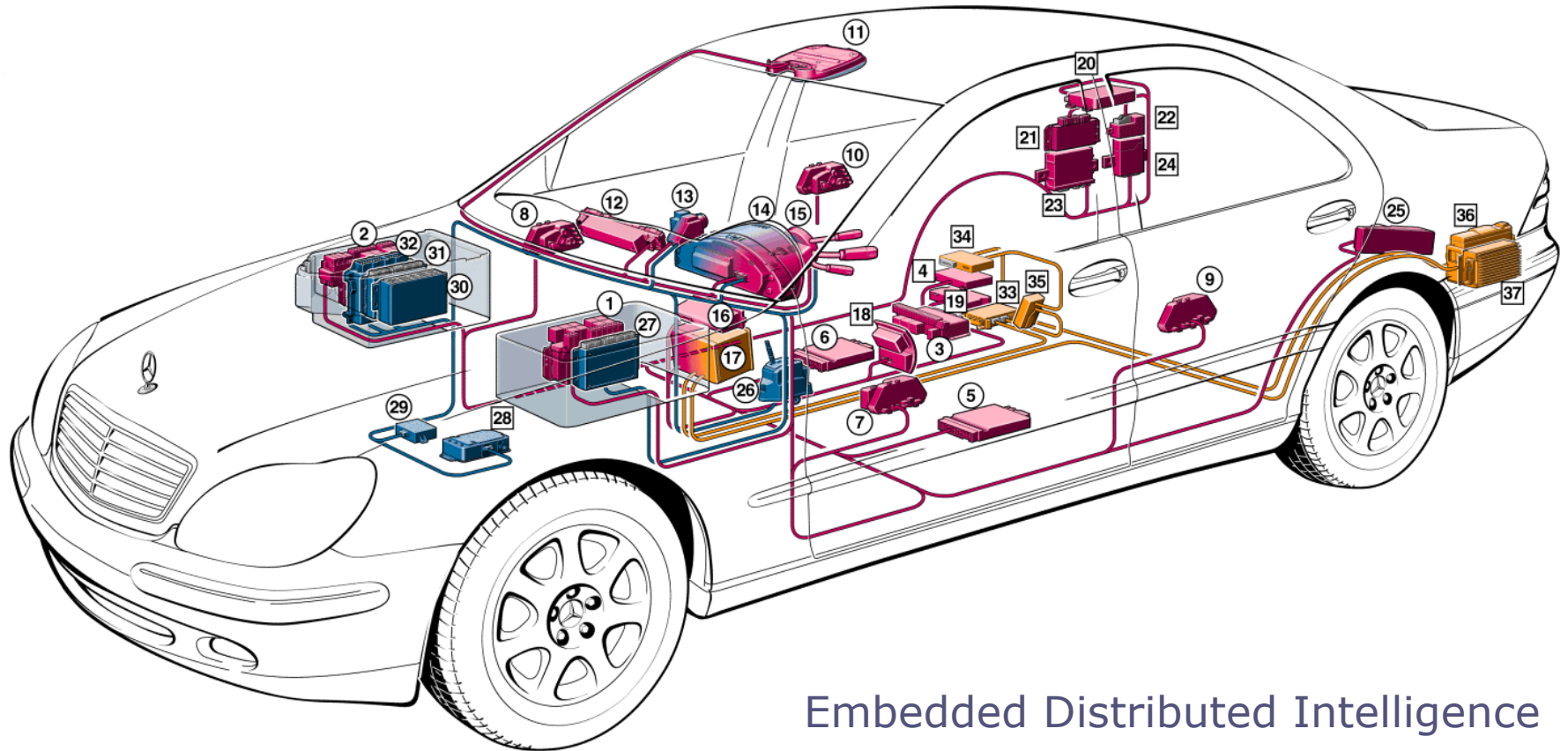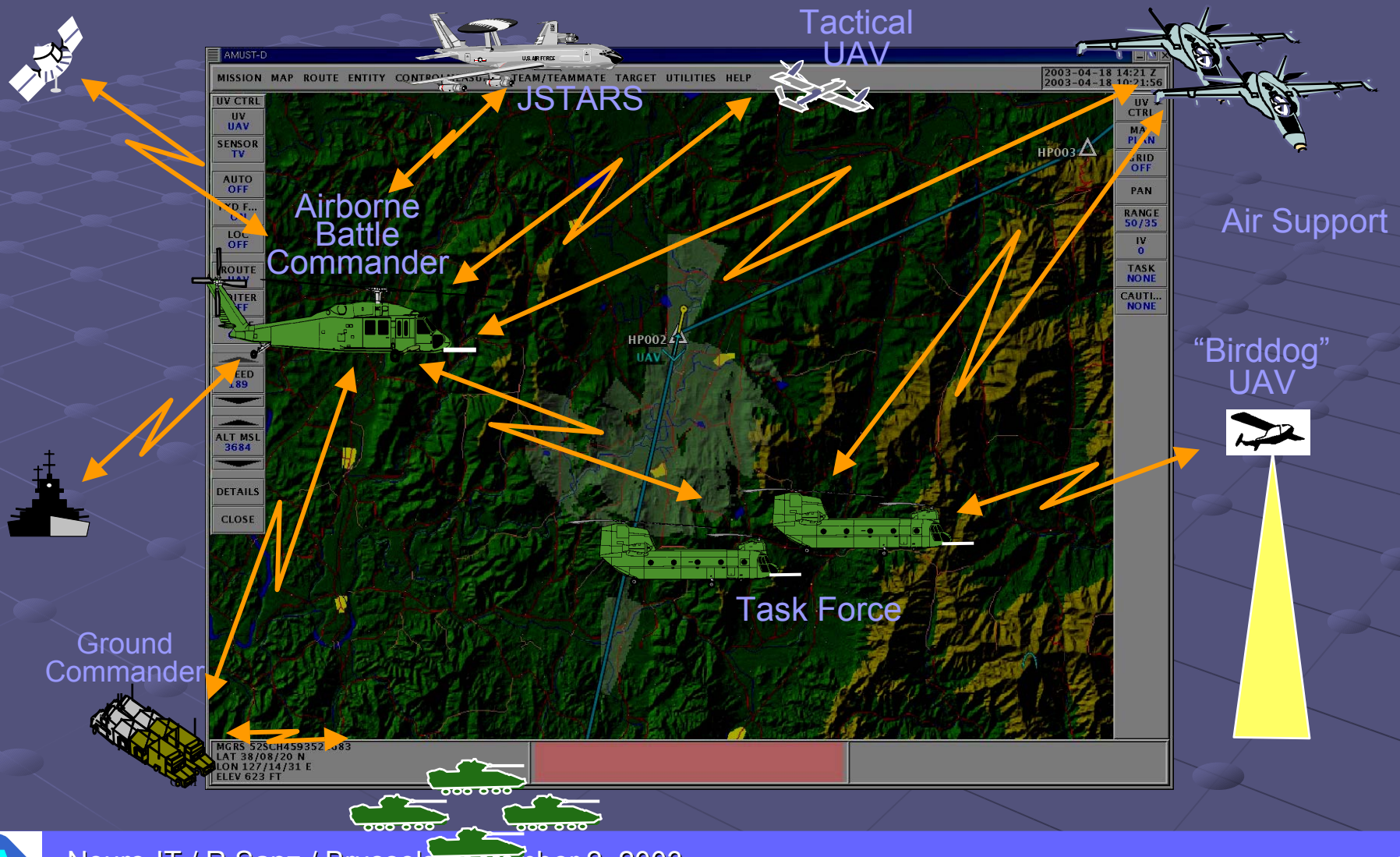*Continuous Process Plant*

Even in small size

CAN Class B

CAN Class C

D²B optical

Embedded Distributed Intelligence

Societies of Intelligences

Tactical UAV

JSTARS

Airborne Battle Commander

Air Support

"Birddog" UAV

Task Force

Ground Commander

AMUST-D

MISSION   MAP   ROUTE   ENTITY   CONTROL   TEAM/TEAMMATE   TARGET   UTILITIES   HELP
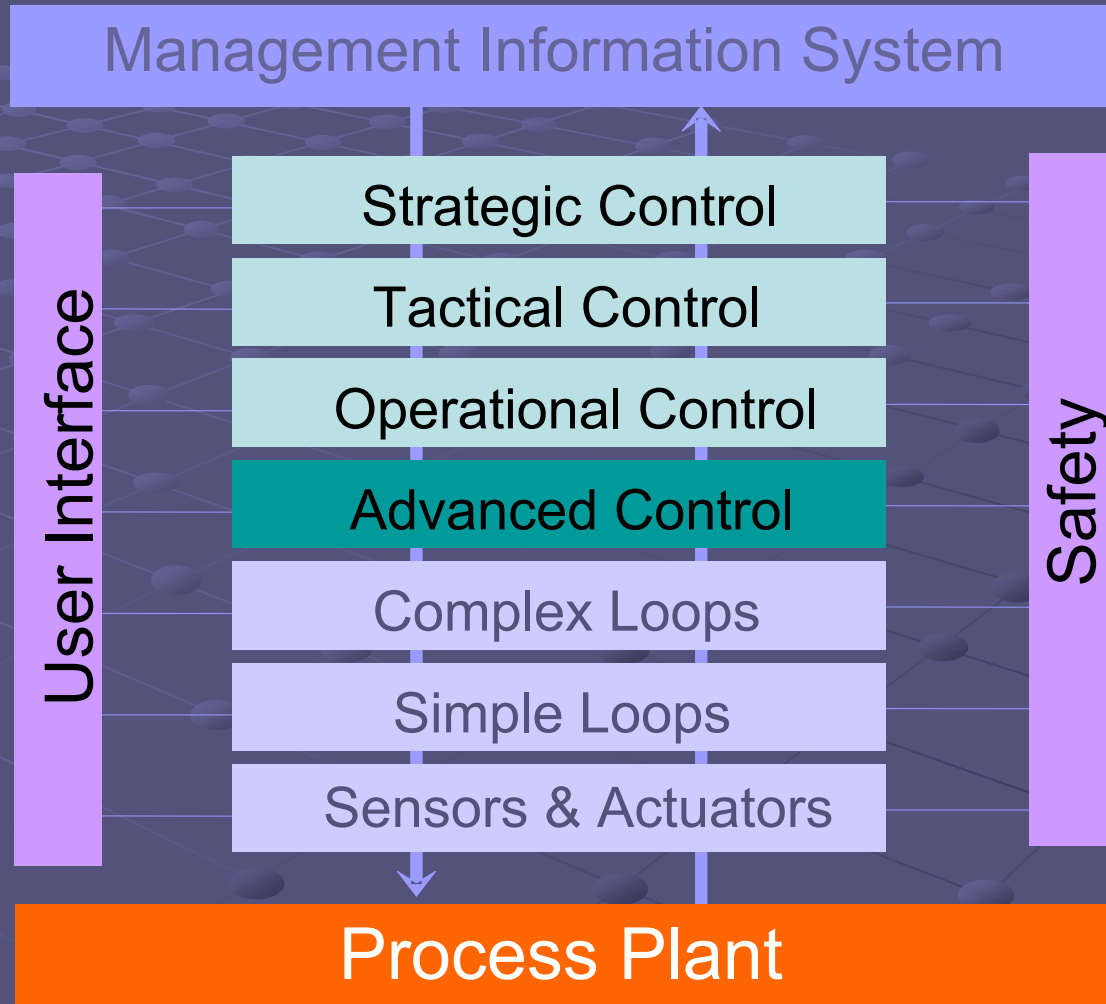
2003-04-18 14:21 Z
2003-04-18 10:21:56

UV CTRL
UV UAV
SENSOR TV
AUTO OFF
LOC OFF
ROUTE
OFF
SPEED 189
ALT MSL 3684
DETAILS
CLOSE

UV CTRL
MA PLAN
GRID OFF
PAN
RANGE 50/35
IV 0
TASK NONE
CAUTI... NONE

HP003
HP002
UAV

MGRS 52SCH459352 083
LAT 38/08/20 N
LON 127/14/31 E
ELEV 623 FT

Multi-agent Systems

Multi-agent System

Environment

Hierarchical Intelligence

Management Information System

User Interface

Safety

- Strategic Control
- Tactical Control
- Operational Control
- Advanced Control
- Complex Loops
- Simple Loops
- Sensors & Actuators

Process Plant

Organic Systems of Objects

Radio Comms Links
Electronic Warfare

Sensors

Combat Center

Weapon Systems

Power and Propulsion

Crew & Crew services

Computing Resources

Weapons Stores

Interconnect and Distribution Systems
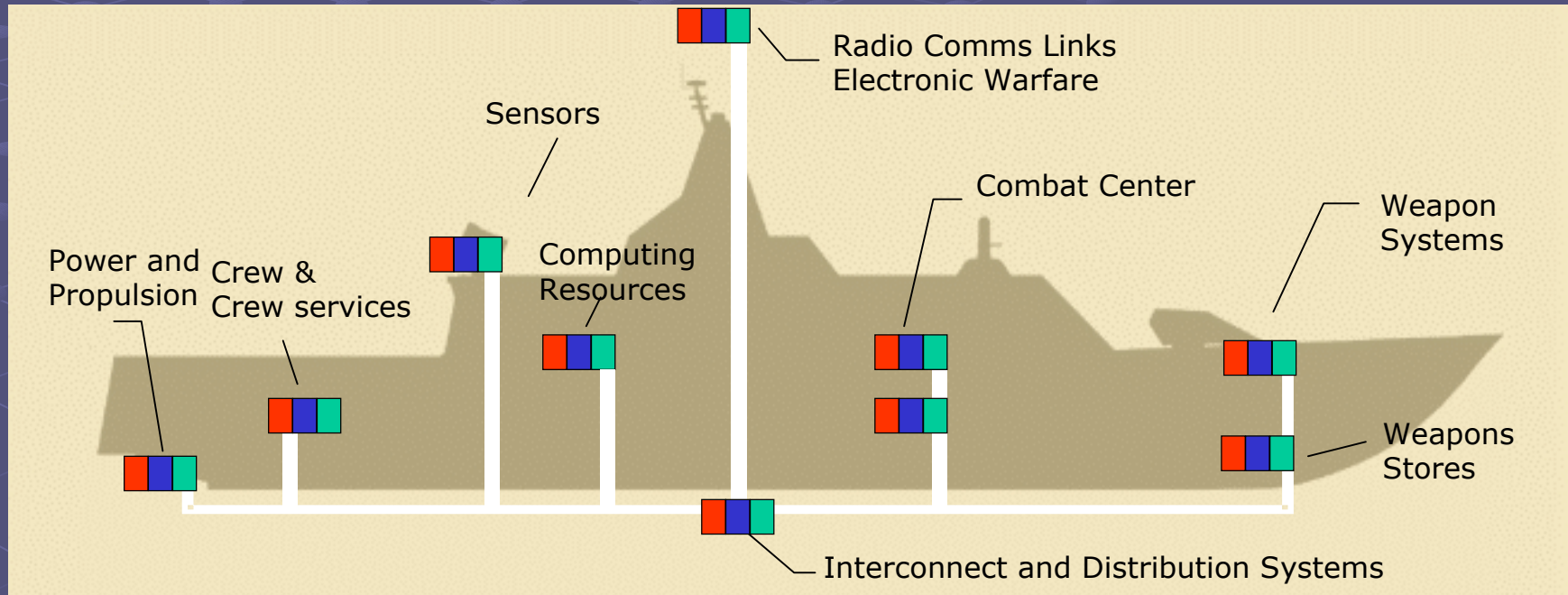
■ Physical Object   ■ Logical Object (In Sys Mgmt Sense)   ■ Network Connection

Scalable Control

◆ **Scalable**
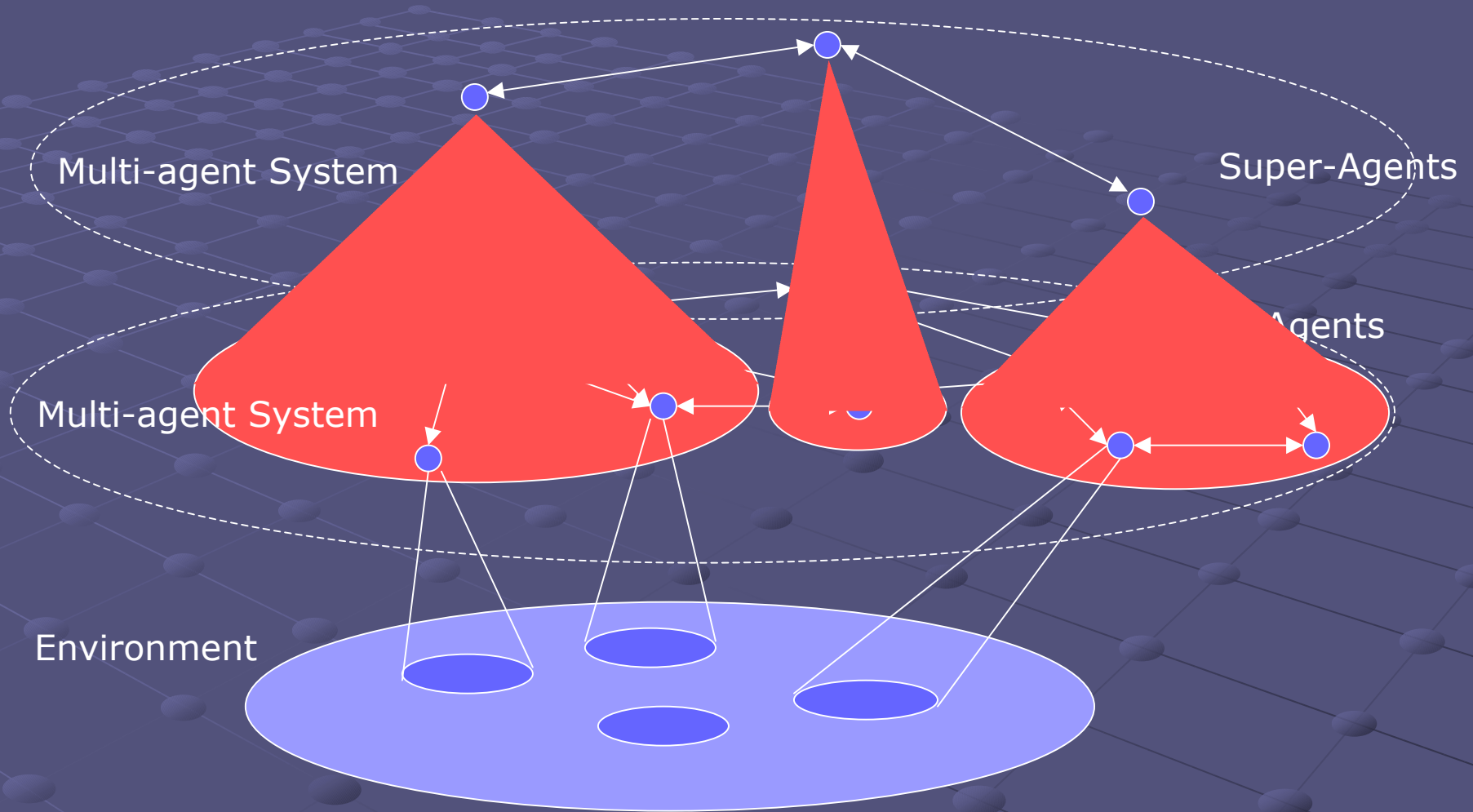\Scal"a*ble\, a. Capable of being scaled.

◆ Scaled to what ?

◆ Dimensions

- Space: complex wide-area plants
- Time: multiple time-scale loops
- Rationality: levels of thought
- Size: down to embeddability
- Organisation: up to consciousness

Agents of Agents

Multi-agent System

Super-Agents

Multi-agent System

Agents

Environment

Complex Control Systems

◆ Now reaching complexity and requirements levels similar to biological systems

What Neuro-IT?

◆ It is not neuroscience

◆ It is not biological ontogenesis

◆ It is not evolutionary psychology

◆ It is Information Technology

◆ It is (perhaps) the most complex Information Technology

What is it ?

◆ Neuro-IT is
Reverse engineering minds/brains to help build better IT applications

◆ What applications?

- Controllers
- That's what minds/brains are

◆ What do we get?

- Task and System-level architectural patterns
- Engineering process patterns

Brief Assessment

◆ Toys and models of biological tissue are not enough

◆ We need scientific theories of cognition

◆ Reverse-engineering neural systems is a valuable work …
… but deep understanding is needed to make it truly useful.

Reverse and Direct Engineering

◆ **Reverse engineering** of minds
  - Understanding mind operation in humans, rats, etc.
  - All functionality/pathology come in single package

◆ **Direct engineering** of minds
  - Building controllers, agents, programs, circuits, etc
  - The engineer decides what to use based on requirements

◆ Awareness, self-awareness, introspection, learning, habituation, priming, etc. come not necessarily in the same package

◆ There are –infinite?– design alternatives

Roadmap Challenges

- ◆ **The Brainprobe**
    - ▪ Reverse engineering human brains (architecture)
- ◆ **Brain-body co-evolution**
    - ▪ Reverse engineering ontogenesis (process)
- ◆ **The "constructed" brain**
    - ▪ A modelling, design and testing platform

- ◆ **Successful in a physical world**
- ◆ **Conscious Machines**
- ◆ **Brain interfaces**
    - ▪ Core control design patterns

New Potential Challenges

◆ Theory of complex biological control

◆ Scalable cognition

◆ Theory of meaning

◆ Emotional control architecture

◆ Removing the mind/body divide

◆ The receding body frontier

◆ Trustable/Dependable/Robust/Certifiable

◆ Alien minds & extended minds

Remarks

◆ Control systems:
- Now reaching complexity and requirements levels similar to biological systems

◆ What is NeuroIT:
- Biological Information Technology acting in the world

◆ NeuroIT Roadmap:
- Solve the fundamental problems linked to the emergence and the modeling of cognition and awareness and associated engineering processes

Conclusion

We need
THEORY
to make our controllers
UNDERSTAND BETTER

what's going on

and what we really want

Autonomous Systems Laboratory

That's all !