Mission Operations Integrated Demonstration Plan

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Overview

- Project Objectives
- Where we are and where we want to be
- Challenges
- Demonstration Objectives
- Implications for Human Centered Systems and Automated Reasoning
- Scenario Description
- Architecture

Project Objectives

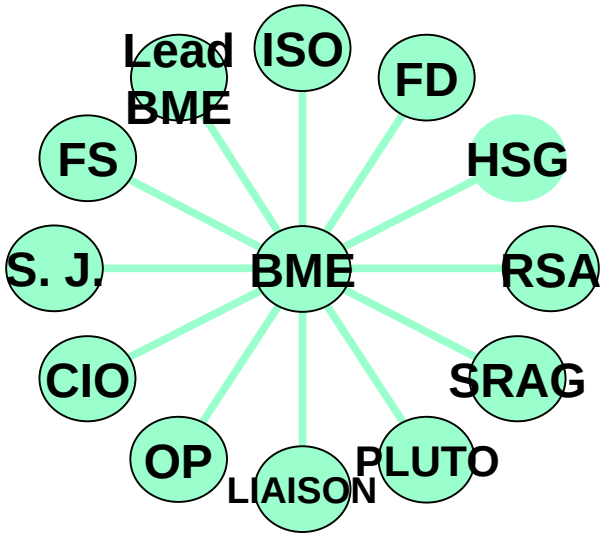
- Develop demonstration system: Model crew and ground operations that use software agents to integrate information management, automated life support and biomedical operations
  - Agents promptly and appropriately inform crew and ground of mission events and autonomous system events
  - Agents support information management and distribution

- Take advantage of synergy between NASA JSC mission operations projects
  - Distributed Crew Interaction
  - Human Centered Intelligent Flight Surgeon Console
  - Human Centered Systems for Mission Operations

Today: Where We Are

- Multi-tasking, task overload
  - Ground performing time-intensive eyes-on monitoring task, mixed with planning, note-taking and communication
    - Located in Mission Control
    - Crew depends on ground monitoring and planning
  - Crew is spending most time on routine operations to maintain the Space Station, mixed with science operations

- Collaboration by pairwise synchronous voice communication
  - Phone, voice loops, Capcom
  - More virtual paths than can be simultaneously managed



Collaboration on TEPC Relocate Issue

one-to-one in large distributed group communication

Where We Want To Be in 10 Years

- Operations concept and assumptions
  - "Virtual" mission control, distributed in space and time
    - Crew has substantial autonomy from ground
    - Mission operations is not confined to control rooms
  - Reduction in routine work
    - Agents handle routine control, planning, operations and information management
    - Ground does periodic checking and troubleshooting instead of continuous monitoring and planning
  - Improved communications and support for multi-tasking
    - Agents manage information flow and support collaborative problem solving
    - Asynchronous communication and broader access reduces interruptions
    - Agents support switching between multiple tasks

Challenges: Supporting Teamwork

- Design to incorporate the cooperation of intelligent control, task planning and reporting
  - Human teams will mix flight operations and other work
  - Agents will coordinate with other agents and tools
- Design to manage potential conflicting actions when multiple human and software agents work together
  - Human teams work in parallel, but still need to synchronize (distributed teamwork)
- Design to overcome dissociation of human team from system operations by automation
  - Naïve understanding of autonomous control can lead to inappropriate response to anomalies

Challenges: "Supervisable" Agents

- Design to supervise and inform other agents or human on
  - What will it report and ask?: Communication expectations
  - What is it doing? What will it do? Why?
    - Understandability and predictability: plans, assessments, procedures, self-assessment

- Design to customize, adapt and control
  - Needs and priorities have changed. How will I change what the agent is doing?
  - Adjustability and control capabilities
  - Specification capabilities
  - Coordination capabilities

The integration and supervision of agents must be easier and safer than not having the agents

Demonstration Objectives

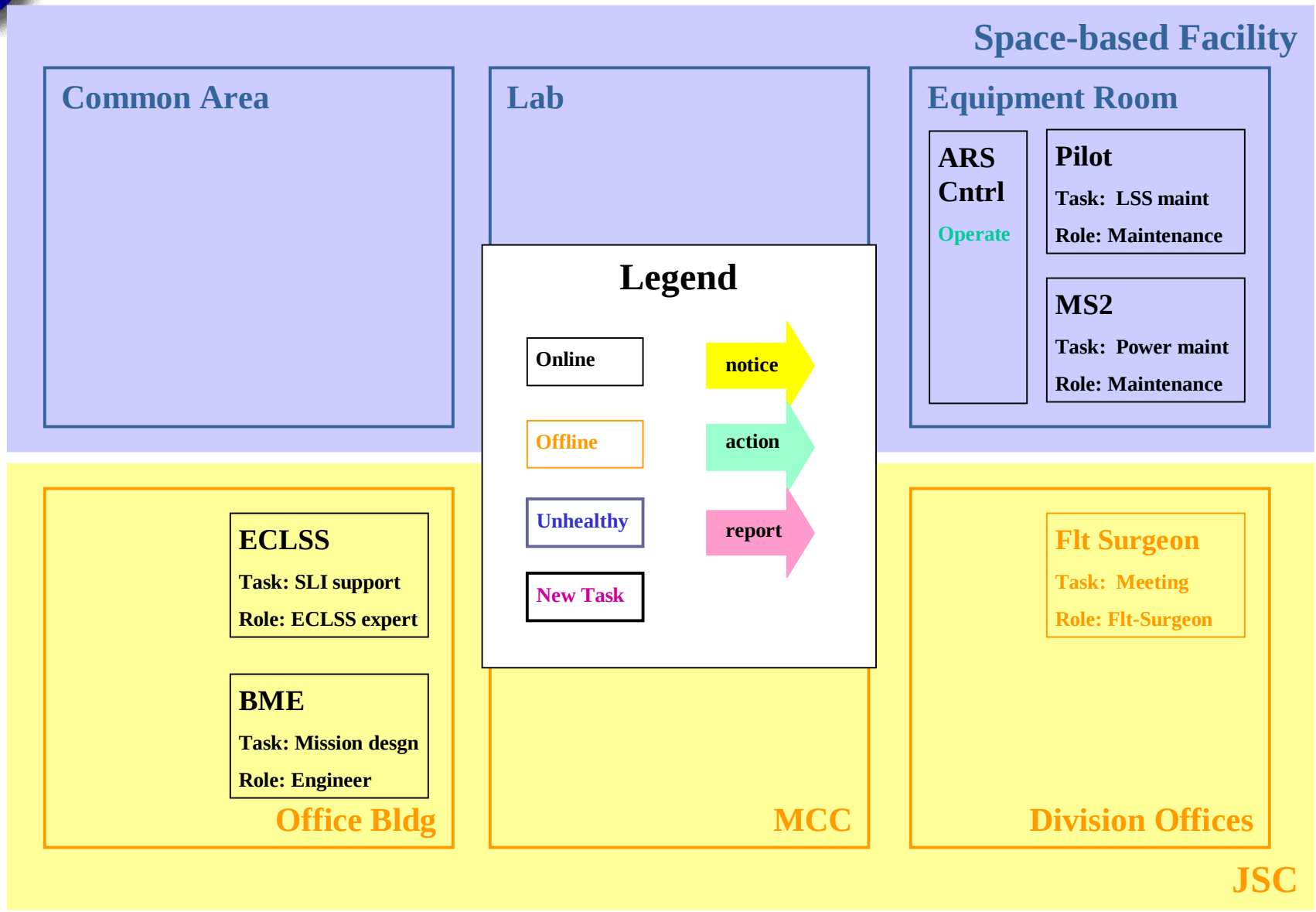
- Multiple, distributed, coordinated human agents and software agents
  - Agents handle time critical tasks and activities for team members
  - Crew and ground team members interact with intelligent agents in the context of other work, with minimal interruptions
  - Agents promptly distribute relevant information on system events, seamlessly and asynchronously across multiple multi-tasking agents
- Superviable agents
  - Crew uses control system adjustable autonomy
  - Ground changes specifications for information handling
- Ubiquitous, web-based computing (on-board and space)
- Use Human-centered methods and products to addressing the design challenges
- Subset of the demonstrated technology is matured for evaluation in an FY04 shuttle or station flight test (DTO)

Implication from HCC & AR

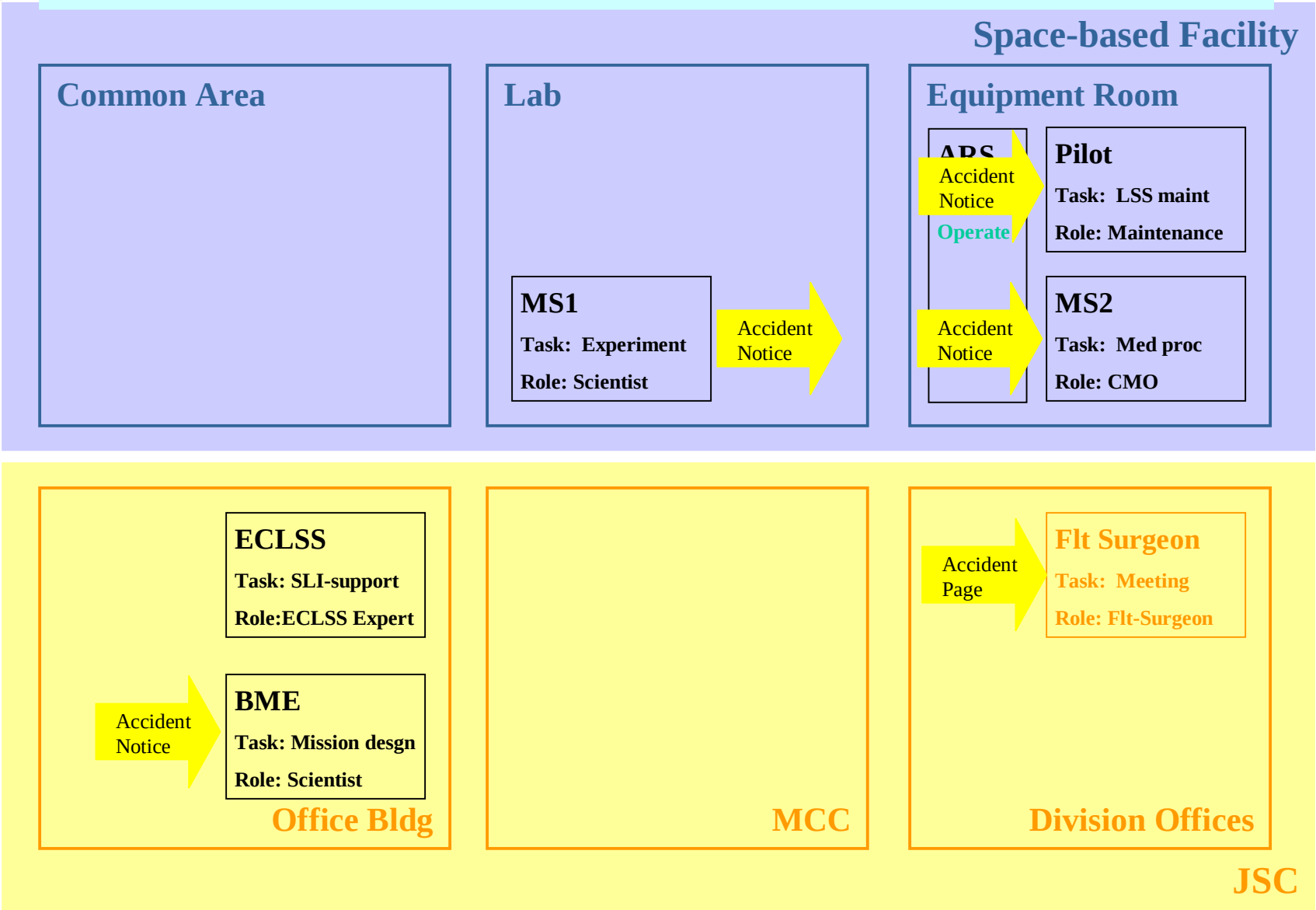
- What we need from human-centered methods
  - Heterogeneous team communication and roles in operations
  - Heterogeneous team negotiation in operations
  - Designer-developer communication and problem solving in development of agents

- What we need from cooperating agents
  - Agent communication and information management
  - Coordination among heterogeneous agents
  - Customizable, adaptable agents for teams

Scenario Description


Space-based Facility
Common Area
Lab
Equipment Room
ARS Cntrl
Operate
Pilot
Task: LSS maint
Role: Maintenance
MS2
Task: Power maint
Role: Maintenance
Legend
Online
Offline
Unhealthy
New Task
notice
action
report
ECLSS
Task: SLI support
Role: ECLSS expert
BME
Task: Mission desgn
Role: Engineer
Office Bldg
MCC
Flt Surgeon
Task: Meeting
Role: Flt-Surgeon
Division Offices
JSC

Inhalation Event: Mission Specialist 1 accidentally inhales ammonia



Response to Inhalation Injusty

Space-based Facility

Common Area

Monitor lungs

Inhalation Procedure

Lab

MS2
Task: Med proced
Role: CMO

MS1
Task: Rest
Role: Scientist

Equipment Room

ARS Cntrl
Operate

Pilot
Task: LSS maint
Role: Maintenance

JSC

Office Bldg

ECLSS
Task: SLI support
Role: ECLSS expert

BME
Task: Mission desgn
Role: Engineer

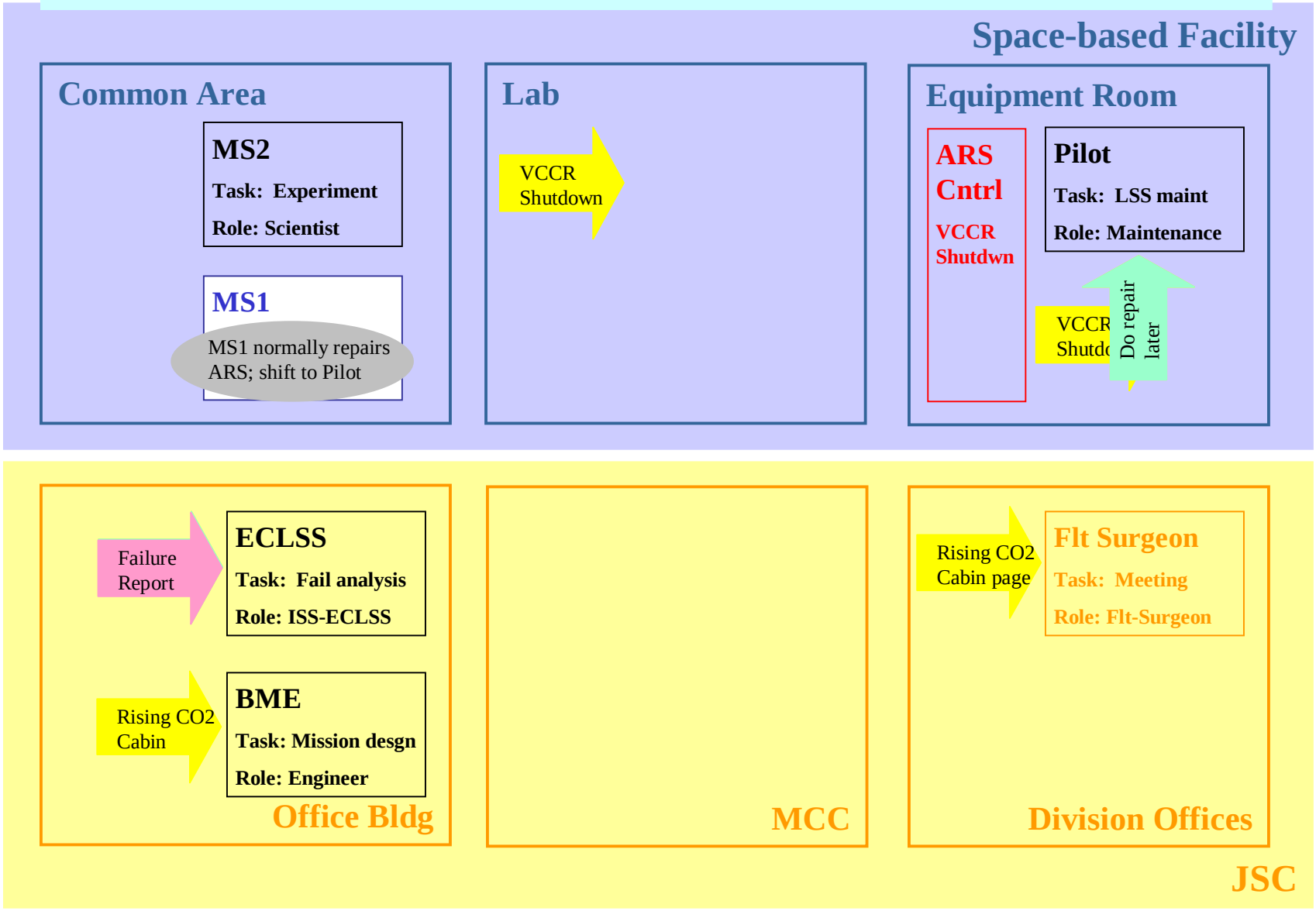
MCC

Division Offices

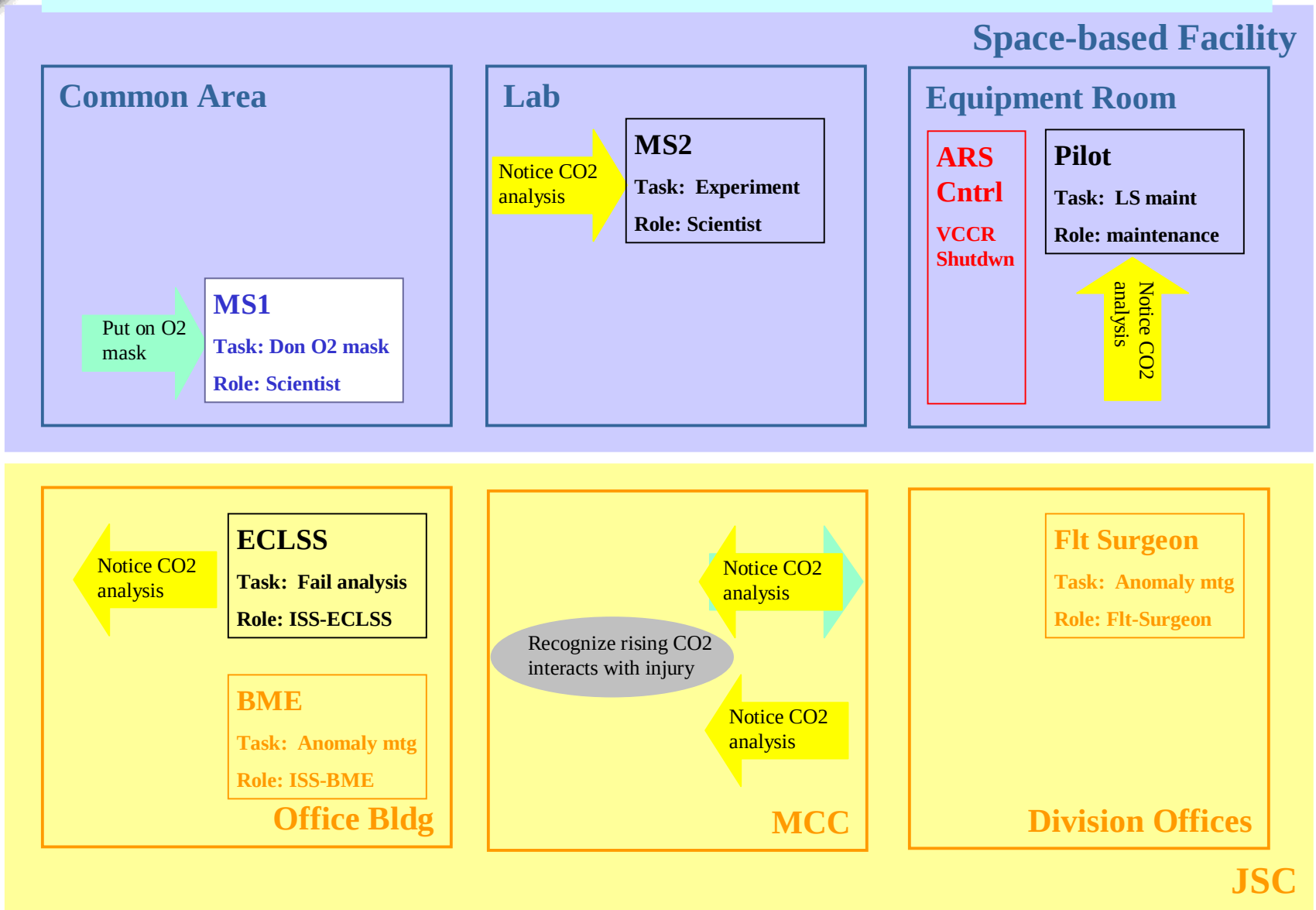
Monitor lungs

Flt Surgeon
Task: Meeting
Role: Flt-Surgeon

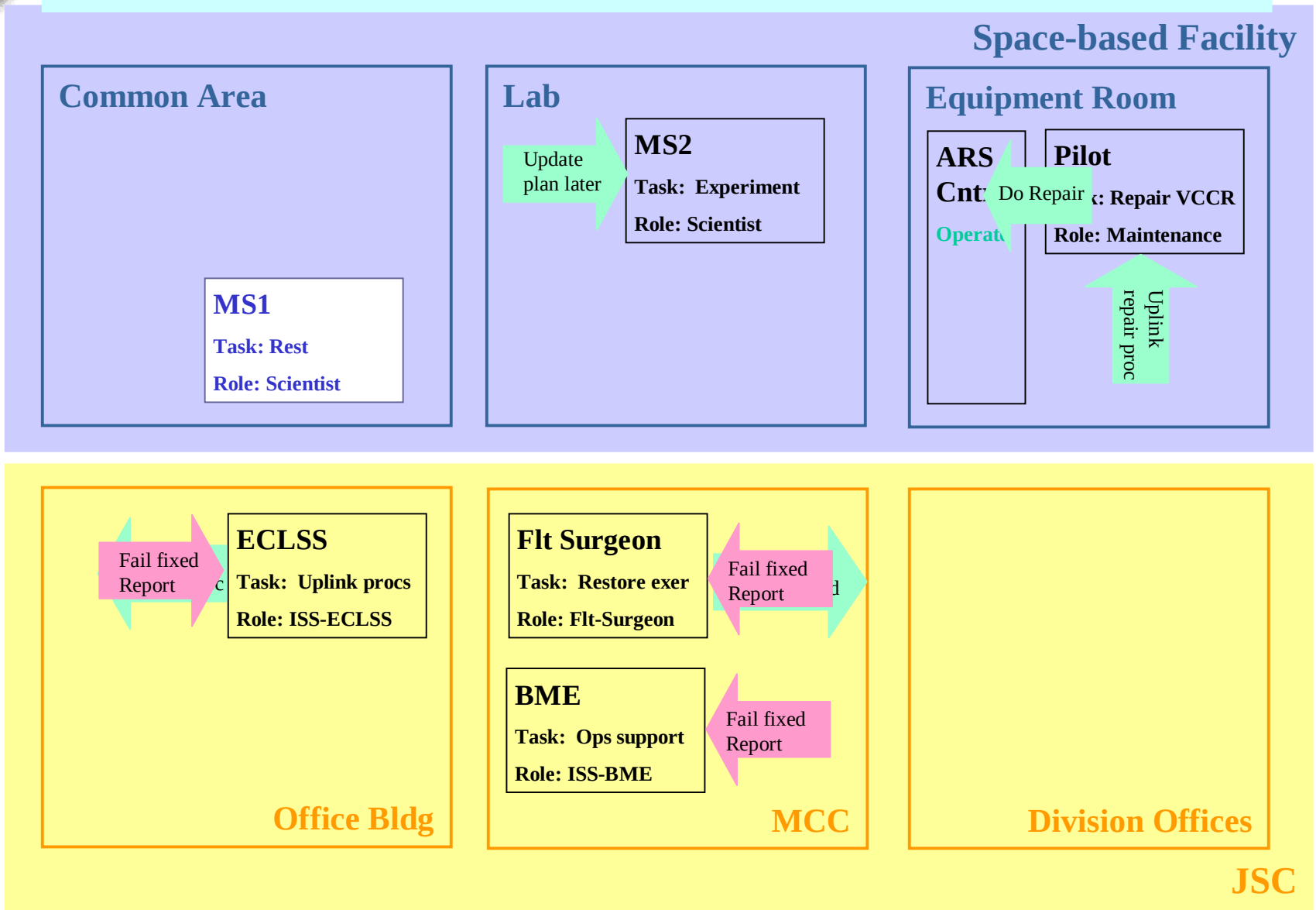
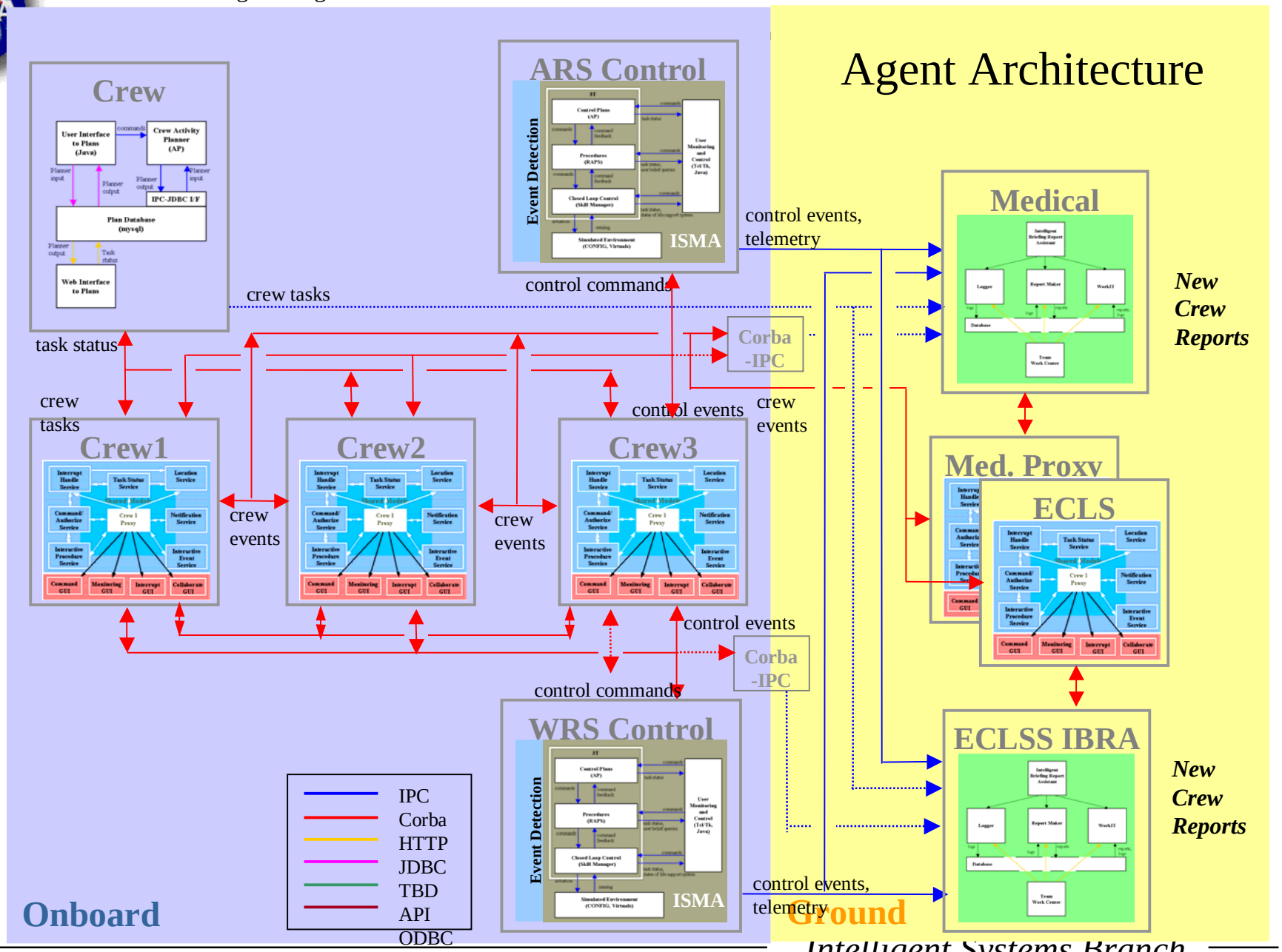
System Failure: Shutdown CO2 removal system



Interacting Events: Inhalation injury and rising CO2 in cabin



Repair CO2 removal system



Agent Architecture