Scenario: Agents for Distributed Team Operations

I. *Nominal Ops:* Crew and ground use information and displays to perform routine, periodic checking of multiple life support systems (under autonomous control) and medical equipment

II. *Anticipated Off-nominal Medical Ops:* Problem of inhalation injury to a crew member, leading to compromised lung function for several weeks. Crew and ground coordinate to assess and resolve the problem, using established procedures.

III. *Anticipated Off-nominal Ops:* Problem arises in CO_2 removal system with potential medical impacts and/or degraded performance

IV. *Unanticipated Off-Nominal Ops:* Events 2 and 3 interact to create a new problem. Rising CO_2 combined with compromised lung function requires novel problem solving by both Surgeon/BME and ECLSS disciplines.

V. *Resume Nominal Ops:* Problem resolved. Routine, periodic checking resumes for system.

I. Nominal Ops: Situation Awareness

Demo starts at mid-day shift handover. Purpose of nominal demo to familiarize the audience with the domain and agent capabilities.

1. Handover of ECLSS position. Incoming ECLSS reads the handover report generated by outgoing ECLSS.
   a. IBRA would create data logs prior to starting demo
   b. At demo startup, the incoming ECLSS flight controller will request the current handover report and review it.
   c. The handover report will be based on a nominal data set.
   d. If HCAAST capability for daily reports is available, the ECLSS flight controller will also review the daily report.
2. Flight controllers annotate the reports, in Report Maker.
3. ARIEL agents assist crew in supervising multiple life support systems under autonomous control
   a. Notices and situation view about life support (mostly queued, few incoming)
4. ARIEL agents assist crew in keeping aware of ongoing activities
   a. Individual crew schedules for the day
   b. Awareness of activities and location of other crew
5. Quickly orient the audience on ISMA displays

I. Nominal Ops: Activity Support

6. ARIEL notifies assigned crew it's time to take water sample and provides access to the procedure for display
7. Crew uses procedure display interface to perform procedure; includes sending activity initiated to ARIEL and ECLSS IBRA
8. When crew completes procedure, procedure displays sends message to ARIEL and ECLSS IBRA indicating activity complete
9. ARIEL marks task complete in crew activity timeline ECLSS IBRA receives activity updates from procedure display
    a. Logs these updates for the daily report

II. Anticipated Off-Nominal Medical Ops

11. Mission Specialist 1 (MS1) inhales low concentration ammonia; be sure MS1 activity in daily schedule using ammonia in experiment
12. All crew are alerted of medical incident by MS1 directly via intercom
    a. Assume no cleaning of area or other safing is required
13. Available crew & MS1 move to treatment center. CMO interacts with his ARIEL agent to notify Flight Surgeon and BME of medical incident
    a. Selects from a pre-fined list of one-click events
14. ARIEL agent for Flight Surgeon notifies him of crew medical event via handheld (DCI architecture can support privacy using special event channel or public-key encryption).
15. ARIEL agent for BME notifies him of crew medical event via display in office
16. Medical IBRA logs crew medical event and opens an issue workspace
17. Once at the site, CMO uses the ARIEL I/F to record crew symptoms and ARIEL sends them to Flight Surgeon and BME.

II. Anticipated Off-Nominal Medical Ops

18. Medical IBRA logs symptoms received from CMO via ARIEL agent
19. Flight Surgeon and BME arrive at Operations Center and prepare to support a medical incident
    a. Set up a private medical comm loop and prepare a Medical Kit
    b. Log into the Team Work Center
20. Flight Surgeon determines inhalation procedure is appropriate based on symptoms and voice loop communication with CMO
21. CMO uses his ARIEL agent interface to find procedure in response to inhalation of ammonia
22. CMO brings up the procedure viewer for the inhalation procedure
23. CMO executes the procedure using the procedure display launched by ARIEL; display capability includes
    a. Select next step based on crew input & recorded data
    b. Log when step is completed & transmit to Medical IBRA
    c. Log medical data & transmit to Medical IBRA

II. Anticipated Off-Nominal Medical Ops

24. Medical IBRA receives notice of executing inhalation procedure
    a. Updates medical emergency workspace with report of procedure steps & medical data from CMO's ARIEL
    b. Pulls together information in workspace: ammonia toxicity, medical procedure
25. Flight Surgeon goes to TWC and sees updated report.
    a. Reviews the updated report
    b. Monitors the medical data as it is collected
26. Flight Surgeon uses voice loop to request CMO to take medical data at one hour as well
27. CMO receives request from Flight Surgeon about 1hr medical data & requests his handheld to remind him
28. CMO interacts with his ARIEL agent to indicate degraded health of MS1 due to inhalation
29. DCI activity planner replans crew activities in response to degraded health of MS1 from his ARIEL agent
    a. MS1 activities are suspended
    b. Other crew tasks may be revised to ensure most important assigned

II. Anticipated Off-Nominal Medical Ops

30. One hour later, CMO is reminded by his handheld to take medical data from injured crew member
31. CMO executes final portion of inhalation procedure and marks it complete; procedure software logs medical data & transmits to Medical IBRA
32. Medical IBRA updates medical emergency report with medical data from CMO's ARIEL. TWC is used to access the report.
33. Flight Surgeon decides MS1 is stabilized with impaired lung function

III. Anticipated Off-Nominal ECLSS Ops

34. ISMA detects problem with CO_2 removal system and sends to IBRA and DCI Event Detection Assistant (EDA)
35. ARIEL agents for crew and ground notify their users of bed leak
    a. Crew are notified of failure diagnosis
    b. Ground ECLSS is notified of failure diagnosis and need to repair
36. ISMA diagnoses problems and shuts down air revitalization system (ARS) for repair; sends to IBRA and DCI EDA
37. ARIEL agents for crew and ground notify their users of shutdown of ARS
    a. Crew are notified of loss of system due to bed leak & impact (CO2 is rising)
    b. Ground ECLSS is notified of loss of system due to bed leak
    c. Flight Surgeon & BME are notified of loss of system & impact (CO2 is rising)
38. DCI activity planner replans to add crew activity to repair CO_2 removal system. This replan is based on the bed leak diagnosis.
39. ARIEL agents for crew scheduled to perform repair notify their users of schedule change

III. Anticipated Off-Nominal ECLSS Ops

40. ECLSS IBRA receives problem data from ISMA and responds as follows
    a. Opens anomaly workspace for bed leak in CO_2 removal system
    b. Creates log entry for bed leak and shutdown of CO_2 removal system
    c. Develops problem report for bed leak
    d. Pulls together relevant flight rules, other reference information
41. Medical IBRA receives shutdown of CO2 removal system from ISMA and responds as follows
    a. Creates medical log entry for potential for rising CO2 in crew cabin
42. In response to notification of bed leak, ECLSS opens the bed leak anomaly workspace
    a. Reviews existing reports and updates as needed. Update includes adding the time the repair is scheduled. Promotes report to internal privacy level.
    b. Reviews log entries
43. In response to notice of rising CO2, BME controller and Flight Surgeon open the bed leak anomaly workspace. Note the BME is in his office and Flight Surgeon goes to MCC.
    a. Reviews existing reports in ECLSS anomaly workspace
    b. Reviews log entries

IV. Unanticipated Off-Nominal Ops

44. Flight Surgeon recognizes that injured crew will be sensitive to increased cabin CO_2 resulting from CO2 removal shutdown
45. Flight Surgeon uses medical emergency workspace as described below
    a. Determines that injured crew member should use an O2 mask when above <TBD> concentration
    b. Determines that flight rules for mandatory crew exercise should be waived to minimize CO2 production
    c. Records decisions in report stored in medical emergency workspace
46. <TBD> information from Flight Surgeon into ECLSS bed leak workspace
47. Flight Surgeon informs Flight Director of decisions and planned uplink
48. Flight Director approves decisions about medical emergency
49. Flight Surgeon uses voice loop to notify BMEs of uplink information
    a. Injured crew member should use oxygen mask when above <TBD>
    b. All crew should stop exercise until further notice
    c. BME responds by generating flight rule waiver

IV. Unanticipated Off-Nominal Ops

50. BME copies CO2 monitoring BRI to BRI for unhealthy crewmember, edits BRI for unhealthy crew member, and starts new temporary IBRA to monitor if cabin CO2 level increases to point injured crew needs O2 mask
    a. IBRA will send agent-initiated event via ARIEL when O2 mask is needed; latch before trigger (implement as function)
    b. IBRA will shut itself down when event is recognized
51. OPS Planner modifies constraints for mandatory exercise in crew activity plan in response to flight rule waiver
52. DCI Activity Planner builds a new schedule without exercise
53. Crew notified by their ARIEL agents of exercise changes in schedule
54. Time passes and co2 rises above <tbd> level; injured crew member puts on oxygen mask
    a. BRI is triggered and IBRA sends agent-initiated event via ARIEL when O2 mask is needed
    b. Flight Surgeon and CMO receives this message (note: pre-approval by Flight Director to send message directly to CMO – usual comm through Capcom)

IV. Unanticipated Off-Nominal Ops

55. CMO informs Flight Surgeon and BME that MS1 has put on his O2 mask via ARIEL
56. Flight Surgeon informs Flight Director that CO2 exceeded limits and injured crew member has put on O2 mask
57. Flight Surgeon updates the medical emergency report with time that CO2 level above limits and O2 mask on MS1