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Developing A Hidden Domain for Human and Electronic Students

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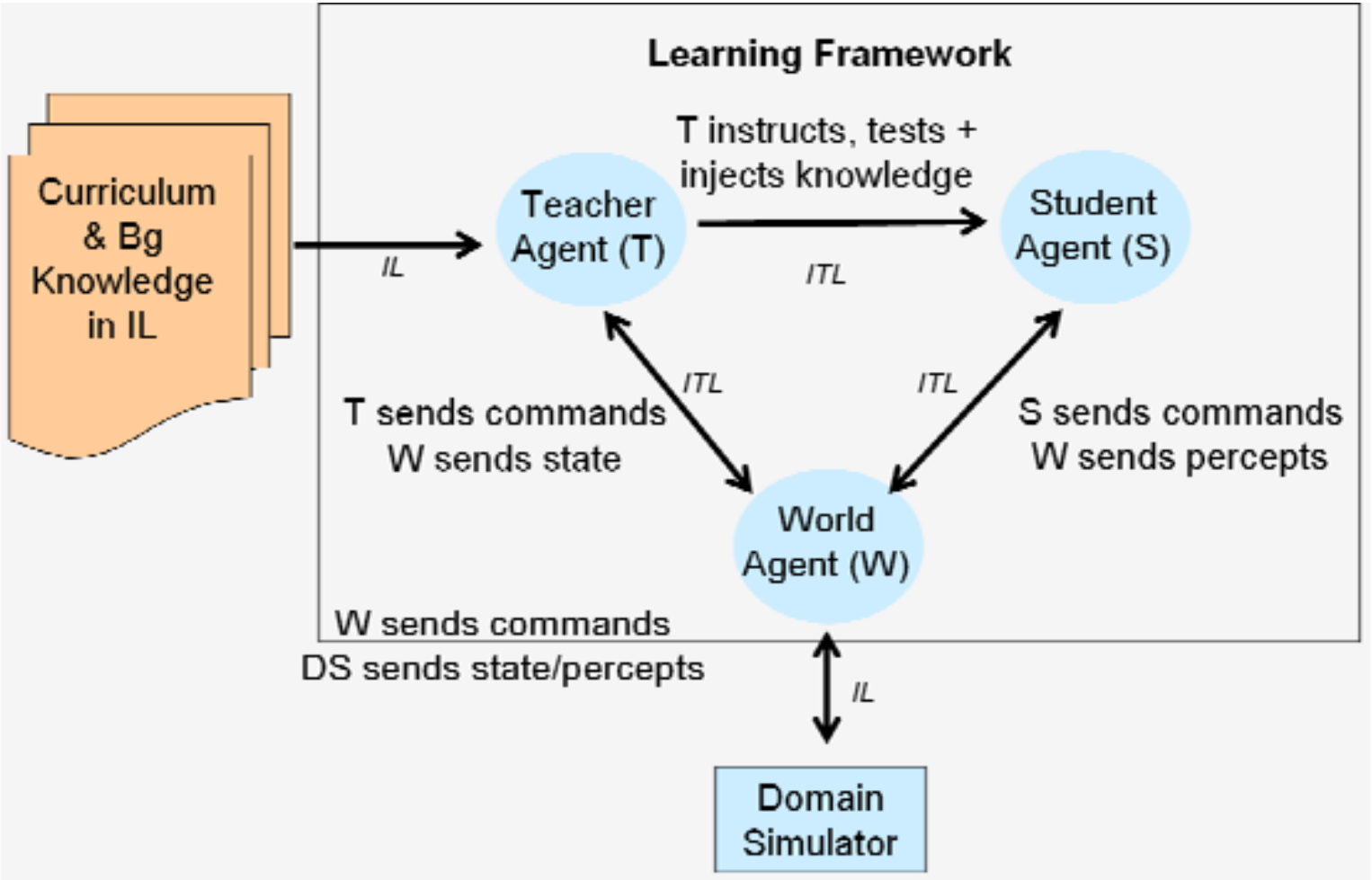
Bootstrap Learning

Objective: Develop an electronic student (e-student) to learn from focused human-style instruction.

Example: Drawing the letter “p”

Bootstrap Learning Framework



From: Robert D. Grant, David DeAngelis, Dan Luu, Dewayne E. Perry and Kathy Ryall. TOWARDS EVALUATING HUMAN-INSTRUCTABLE SOFTWARE AGENTS, IHCI 2011, Rome, July 2011

Role of Curriculum

1. Instruct the e-student
2. Test the e-student

Advantages of a defined set of curricula:

- Algorithm development
- E-student testing
- Developing a repository

HD Requirements

1. Open to learning from experience
2. Need to learn from experience to succeed
3. Explicit reasoning
4. Elements easily visible to and encoded by an automated system
5. Problems come up reasonably often in real life

Role of Human Comparison

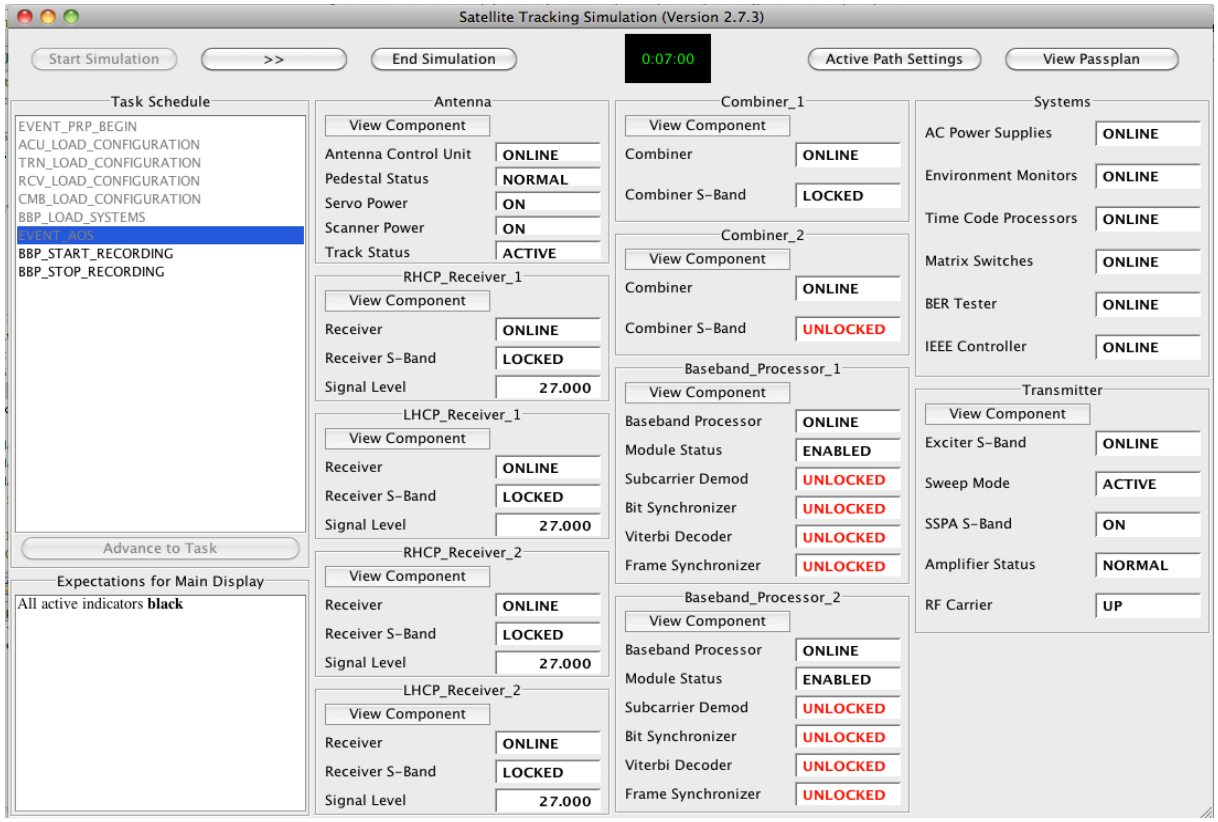
Curriculum is necessary and sufficient

Provide baseline for expected e-student performance

Human Comparison Requirements

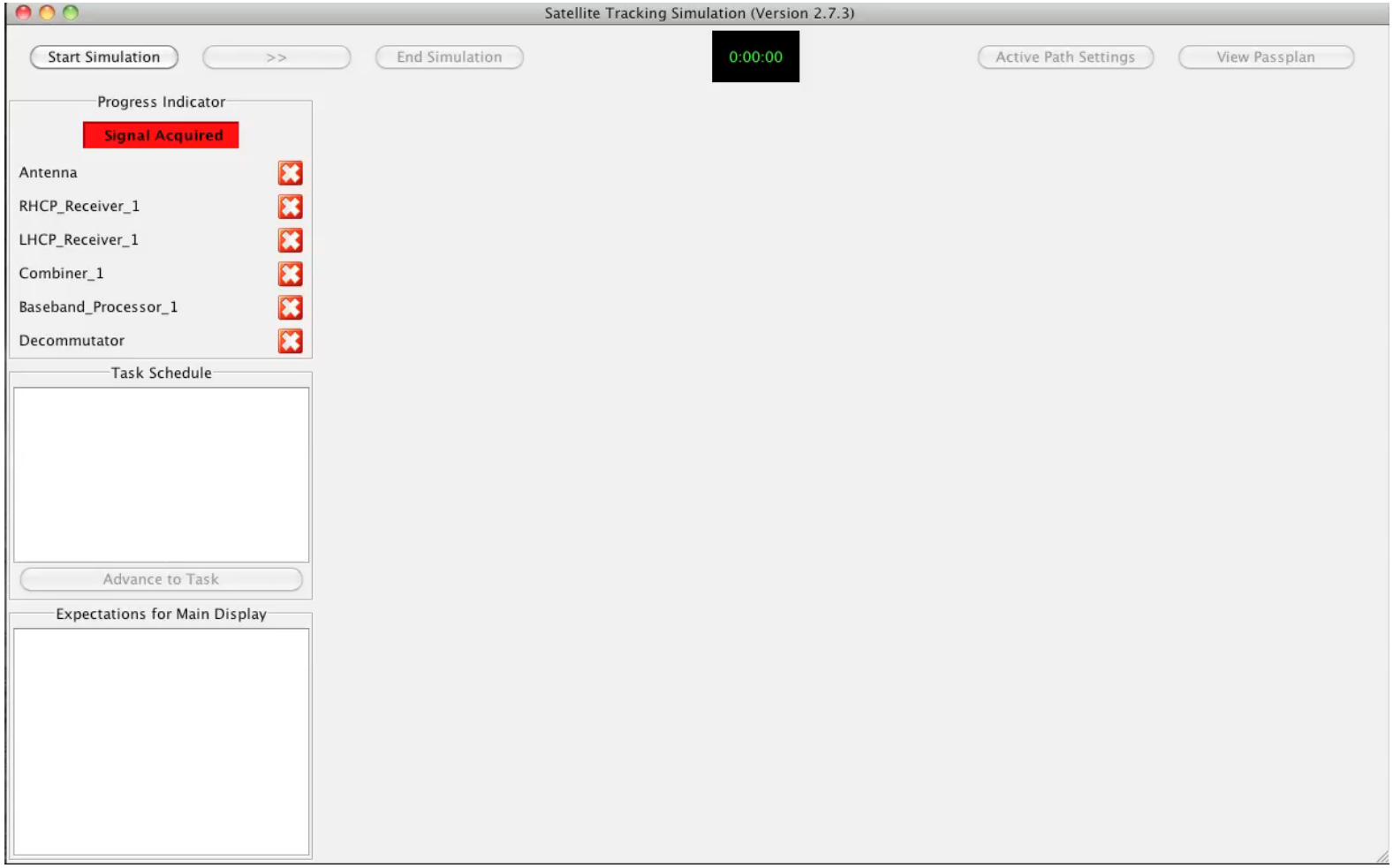
6. Include problems that will challenge the human students.
7. But not too challenging
8. Same problems will be presented to human students and the e-student.

Ground Station Domain



Student fills the role of ground station operator, controlling satellite communication

Demonstration



Laddered Curriculum

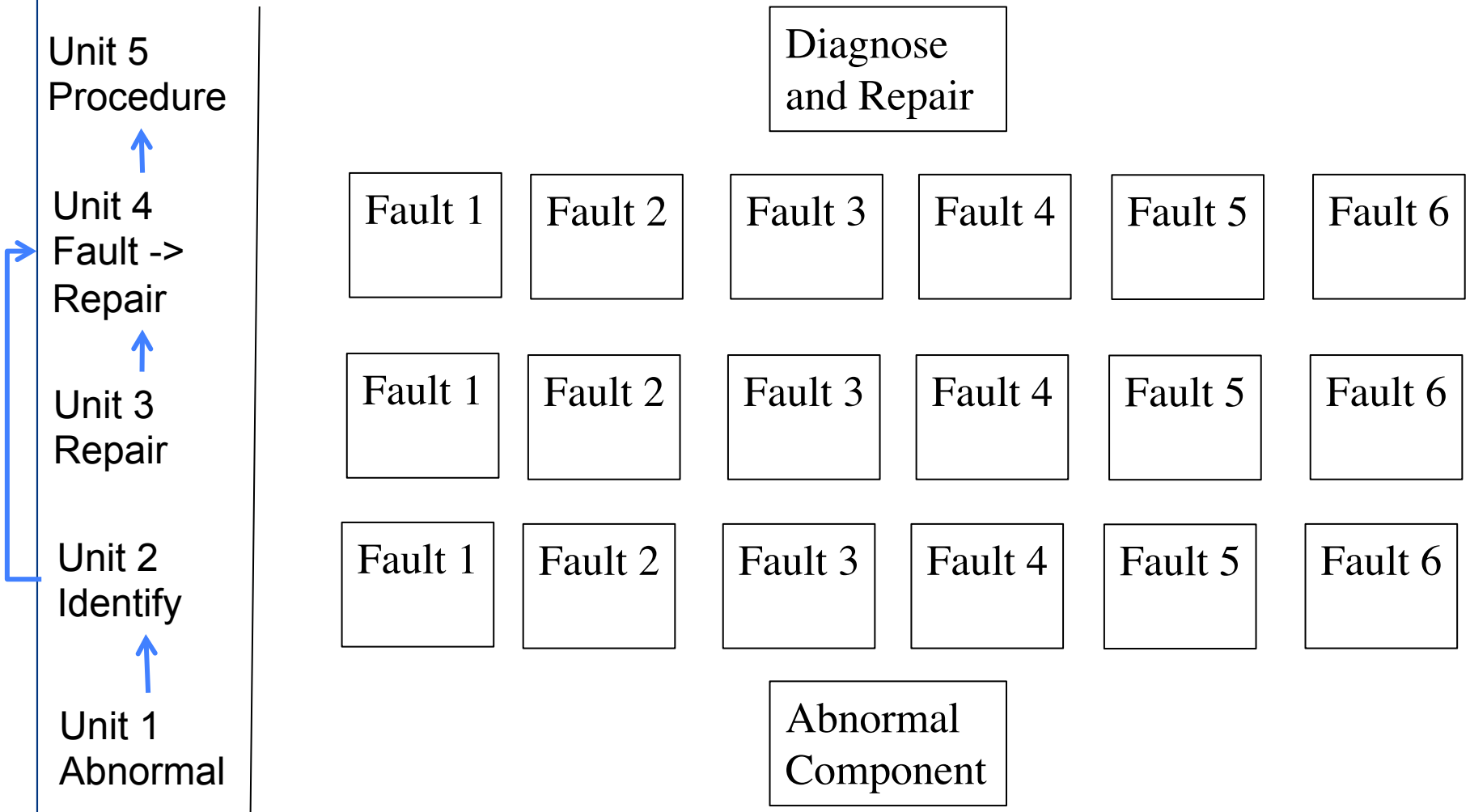
Each rung in the ladder:

- Is single a concept (e.g. procedure, pattern)
- Contains multiple lessons by telling, example, or feedback

Rungs build on top of one another to form a ladder

Units are used to group related rungs

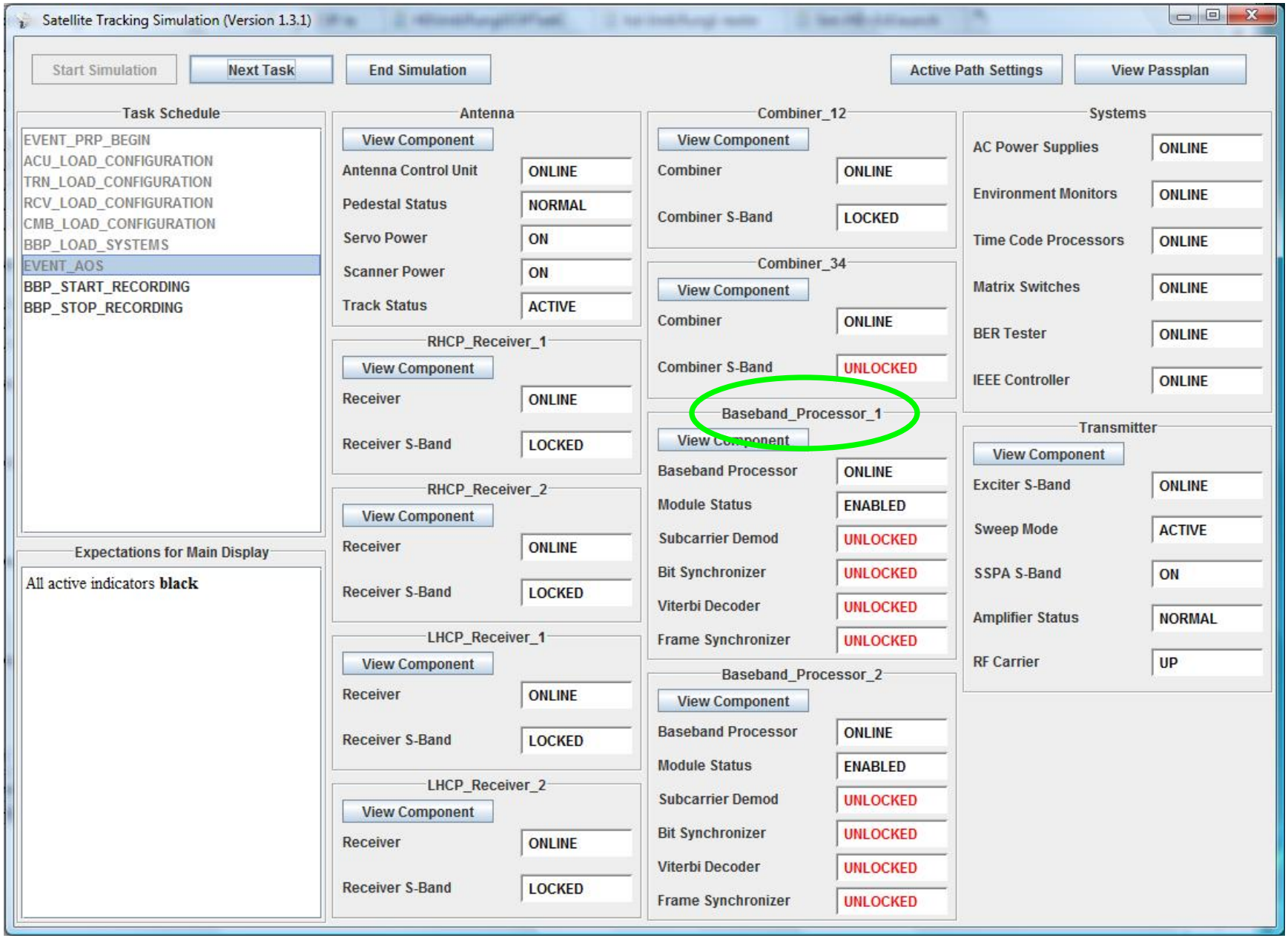
Phase II Laddered Curriculum



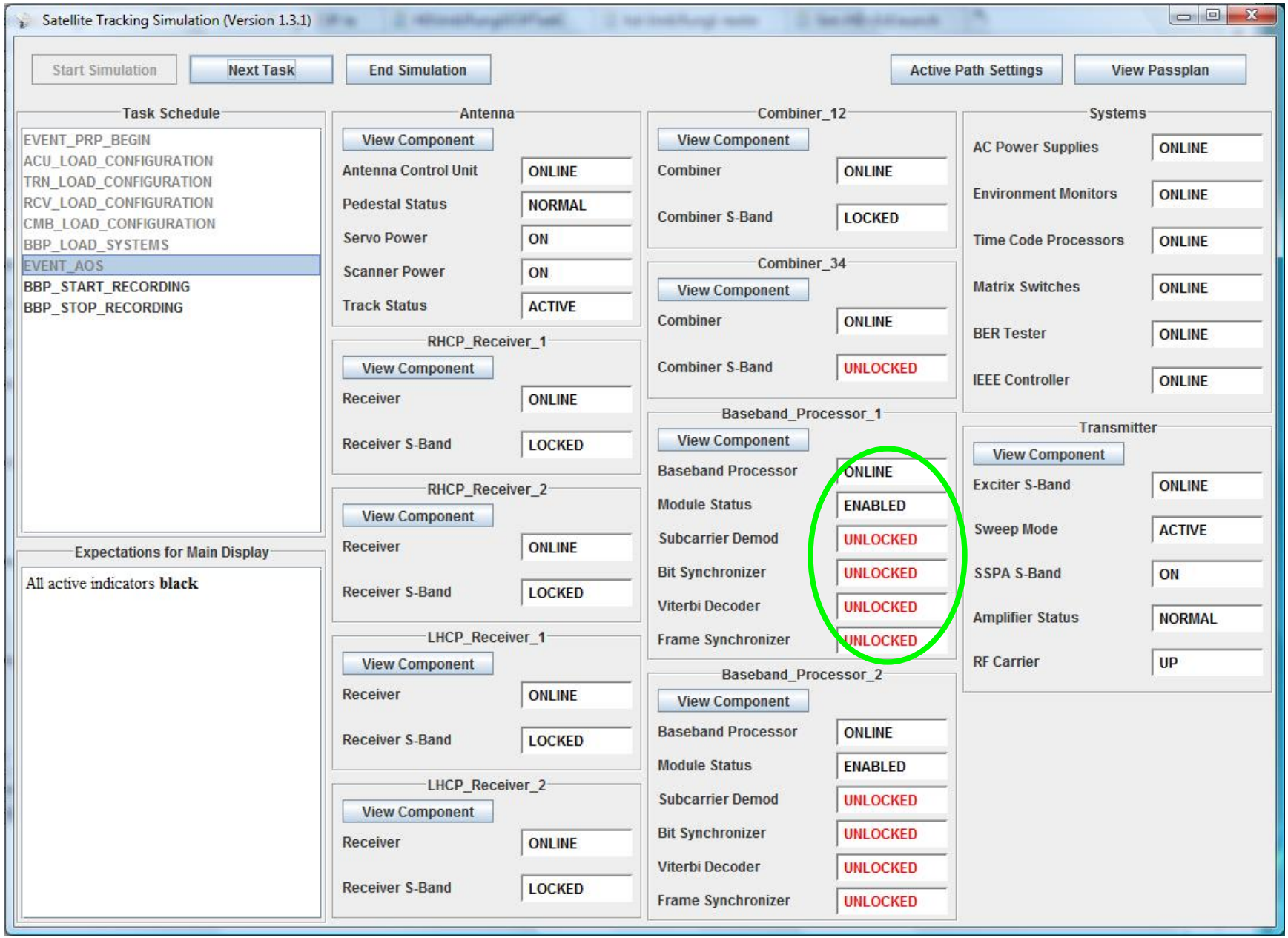
Example Human Lesson

This lesson teaches what *abnormal component* means.

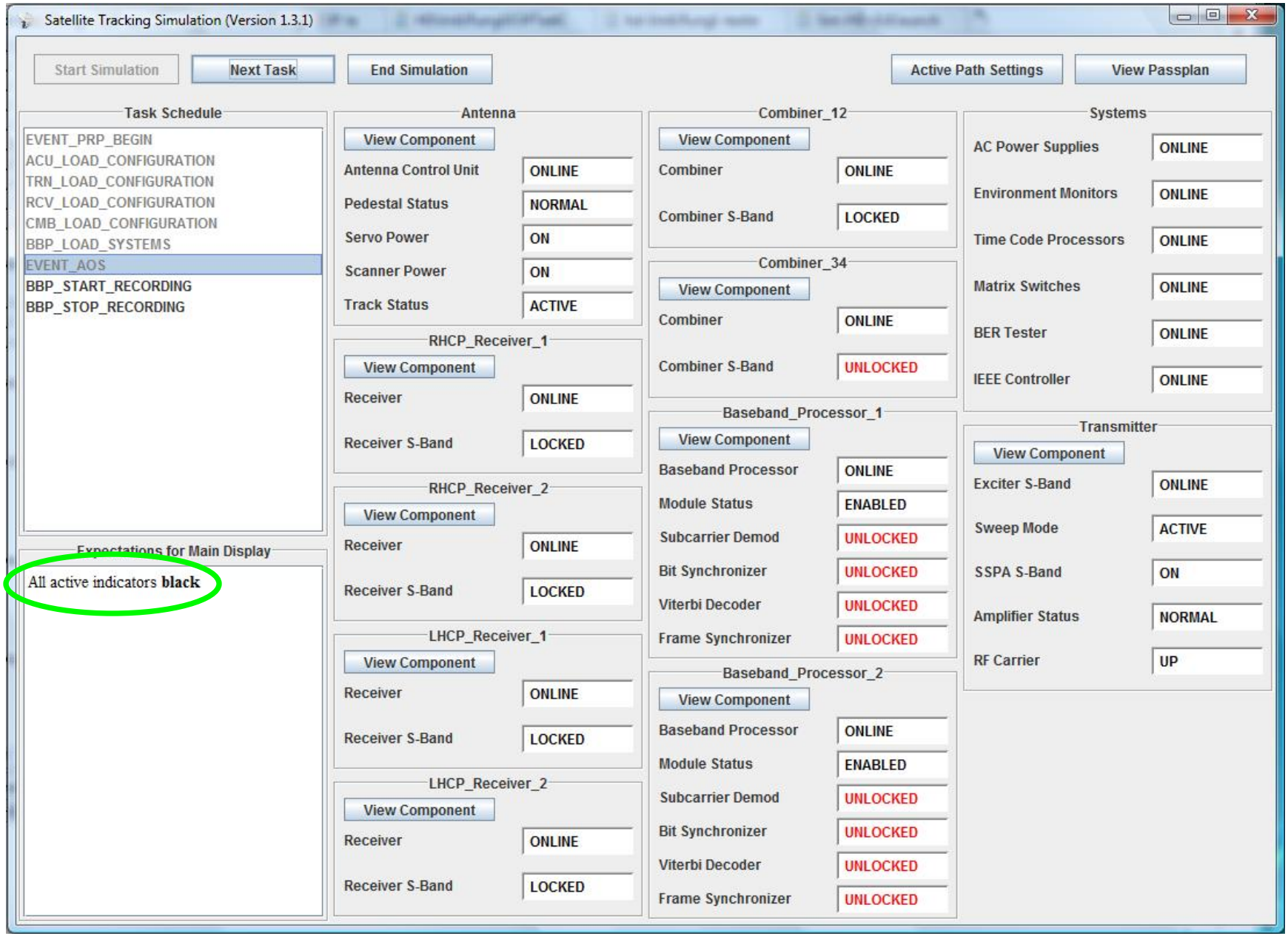
I will provide examples.



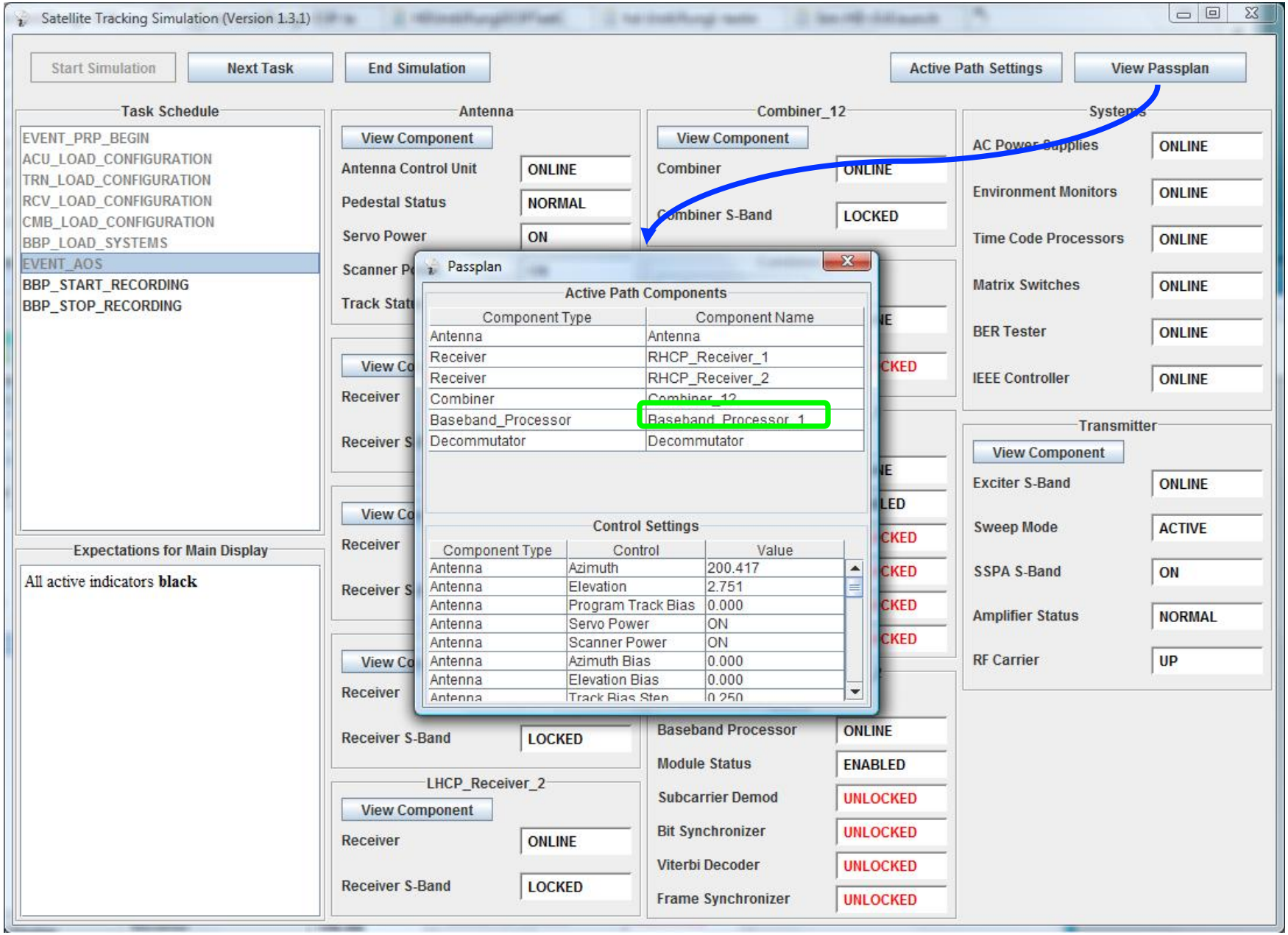
Baseband_Processor_1 is an *abnormal component.*



Notice that some of these indicators are **red**.



Notice that the Baseband_Processor_1 indicators are expected to be **black**.



Notice that Baseband_Processor_1 is on the active path.

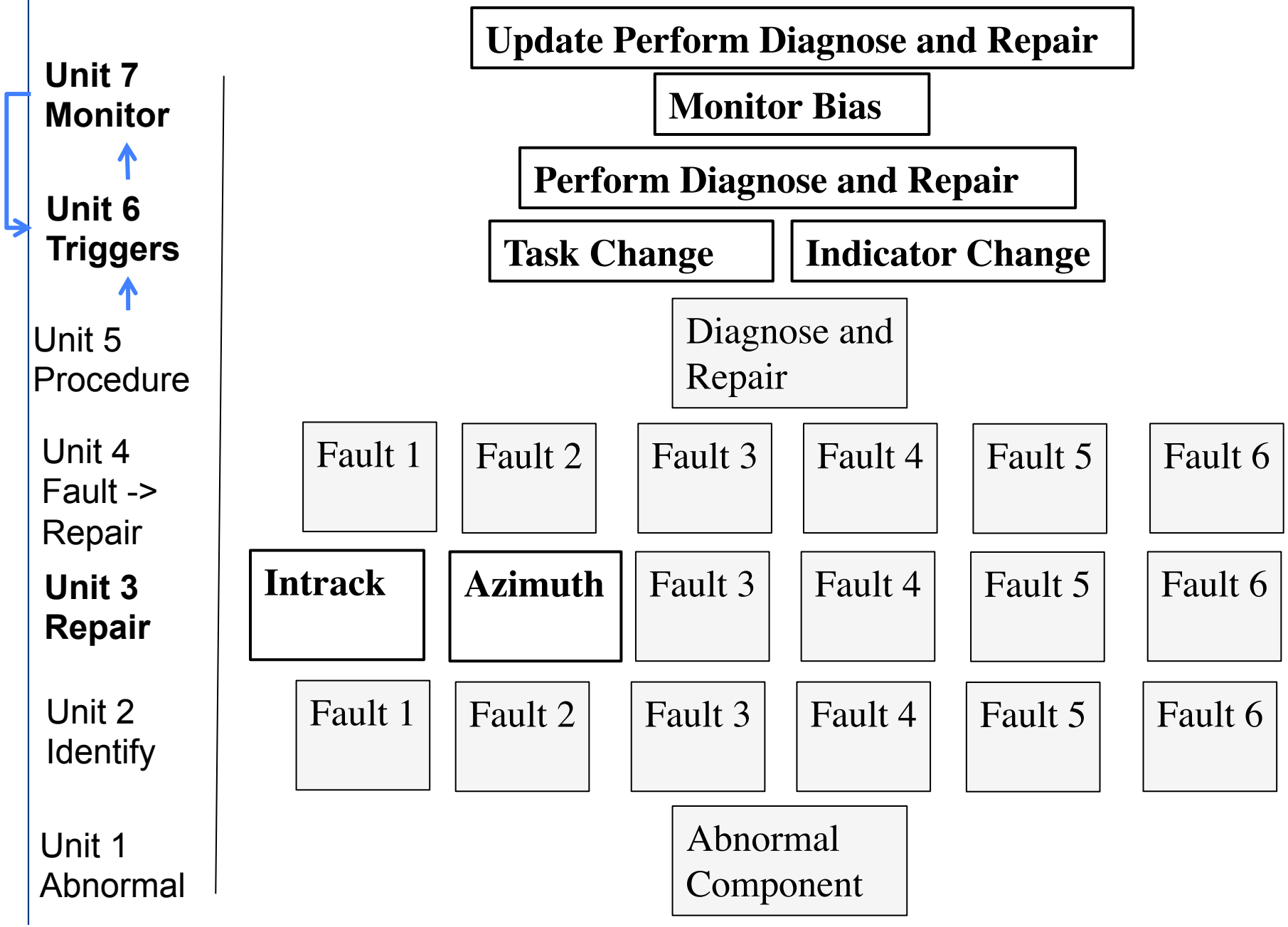
We’re done with this example.

Example e-student Trace

```
Lesson:  HD-Abnormal-CBE-LearningLesson
[ Utter(
  name=Utter-3574,
  timestamp=Timestamp(system=lesson,offset=379),
  utterance=LessonTeaches(name=LessonTeaches-3573,arg1=WhenTrue(name=WhenTrue-3572,arg1=Abnormal)),
  addressee=Student(name=theStudent)) ]
[ Utter(
  name=Utter-3591,
  timestamp=Timestamp(system=lesson,offset=574),utterance=Method(name=Method-3590,arg1=byExample),
  addressee=Student(name=theStudent)) ]
[ Imperative(
  name=Imperative-3635,
  timestamp=Timestamp(system=lesson,offset=808),
  request=startSimulation(name=startSimulation-3634,modifiers=[0],faults=["Antenna_Motion_Error"]),
  addressee=World(name=theWorld)) ]
[ WorldDone(
  name=WorldDone-3644,
  timestamp=Timestamp(system=lesson,offset=1952),imperative=Imperative-3635,source=World(name=theWorld),
  addressee=Teacher(name=theTeacher)) ]
[ Perception(
  name=Perception-3646,
  timestamp=Timestamp(system=lesson,offset=2025),
  gainedPercepts=[
    ComponentConnection(
```

… for about 70 more pages

Phase III Laddered Curriculum



Performance Results

	Phase II	Phase III
Human	91%	81%
eStudent	100%	100%

Results are not intended for direct comparison:

- Does not include all units
- Does not include injection penalties

Future Work

Significant future work exists in the challenges contained in this curriculum that were tested on humans but not addressed by the e-student:

- Complicated repair procedures
- Analogous repair procedures
- Context-based monitoring
- Concept revision

Acknowledgements

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Questions?