TIMED

Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics

TIMED Simulators

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Simulators - Introduction

Two Spacecraft-level Simulators:

- **TIMED OPerations Simulator (TOPS)** will provide for pre- and post-launch validation of operational procedures, flight software upgrades and other uses.
- **TIMED INTegration Simulator (TINTS)** will be a test bed for flight system I&T.

Simulators - TOPS Introduction

- **TOPS - the TIMED OPerations Simulator**
- **"Satellite-on-the-ground"** - validate ops procedures, flight code updates, autonomy rule changes both pre- and post-launch.
- **Spacecraft Test Bed (STB)** - Part of Mission Ops Team STB.
- **"Hardware-in-the-loop"** simulator - contains EM's of critical TIMED subsystems, including associated flight software, elements of the subsystem GSEs needed to simulate and/or stimulate all inputs.

Simulators - TOPS Requirements

TOPS shall perform the following:

1. Rehearse spacecraft events.
2. Validate & test autonomy rule changes.
3. Validate & test flight software changes.
4. Predict Solid State Recorder detailed performance.
5. Predict G&C detailed performance.
6. Test and train operators.
7. Reconstruct flight system anomalies.
8. Estimate contact timing.
9. Verify MOC operation.

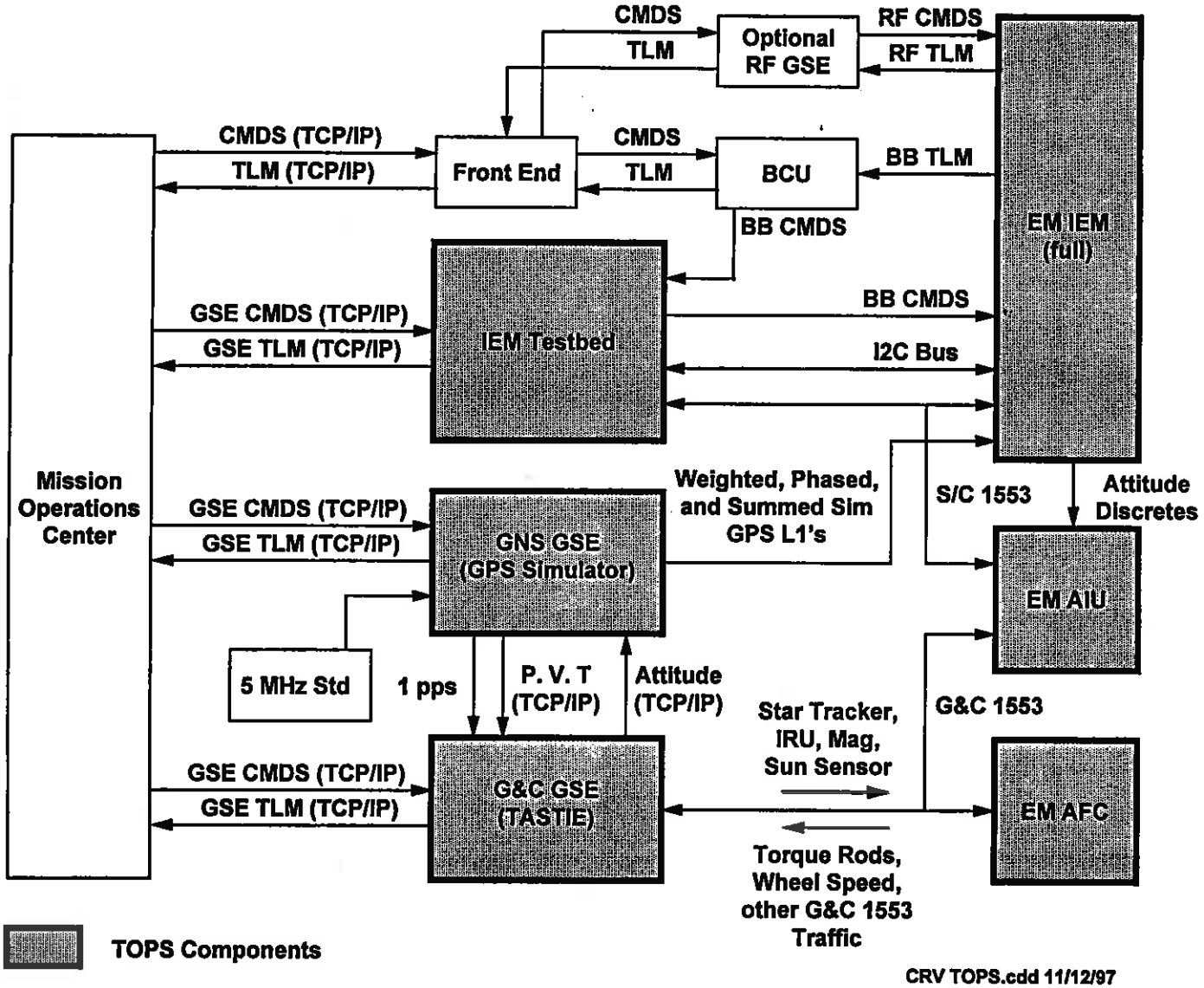
Simulators - TOPS Concepts, p1 of 2

- **EM's** - redundant AIU and AFC, single IEM
- **GSE's** -
  - **IEM Test Bed**
  - **GPS Simulator**
  - **G&C TASTIE**
- **MOC control**
- **RF and Power - simulated only** (can add as needed)
- **Instruments - not part of TOPS**
- **Validation** - validate relative to TINTS and TIMED before launch using subset of Baseline Performance Test

Simulators - TOPS Concepts , p2 of 2

- **Fidelity - Can be very high**, even for unintended and undocumented aspects of the system, **provided**
  1. **faithful copy of the flight system**
  2. **proper initial state**
  3. **inputs precisely simulated**
- **Real time simulator - must run at the real time rate.**
- **User Interface - Nearly identical to TIMED spacecraft** on orbit, allows use of flight command loads and telemetry analysis tools, makes TOPS ideal for operator test/train. (Some additional control from the MOC will be needed to initialize the simulator and control the simulated inputs.)

TIMED OPerations Simulator (TOPS)



Simulators - TOPS Issues

- **Availability -**
  - Operations desires TOPS from early in I&T, however, this is not practical due to budget and schedule. Plan is to have TOPS integrated, validated, and available at start of environmental qualification.
  - Will TOPS be available as needed?, ie, to what extent will emergencies require continuing use of TOPS components by subsystem team?
- **EMs must match flight components** as closely as possible. Flight software must run on TOPS without modifications.
- **GSEs must be maintainable** (and maintained).
- **Performance validation** is critical. Thoroughly understand any performance differences vs. flight system which aren't eliminated.

Simulators - TINTS Introduction

- **TINTS - the TIMED INTegration Simulator**
- **Test bed** for the flight system during integration, environmental qual, and pre-launch check-out.
- **"Hardware-in-the-loop"** simulator - contains elements of the subsystem GSEs needed to simulate and/or stimulate all sensors for subsystem-level and system-level tests, plus any additional interfaces and control elements needed to tie the pieces together.

Simulators - TINTS Requirements

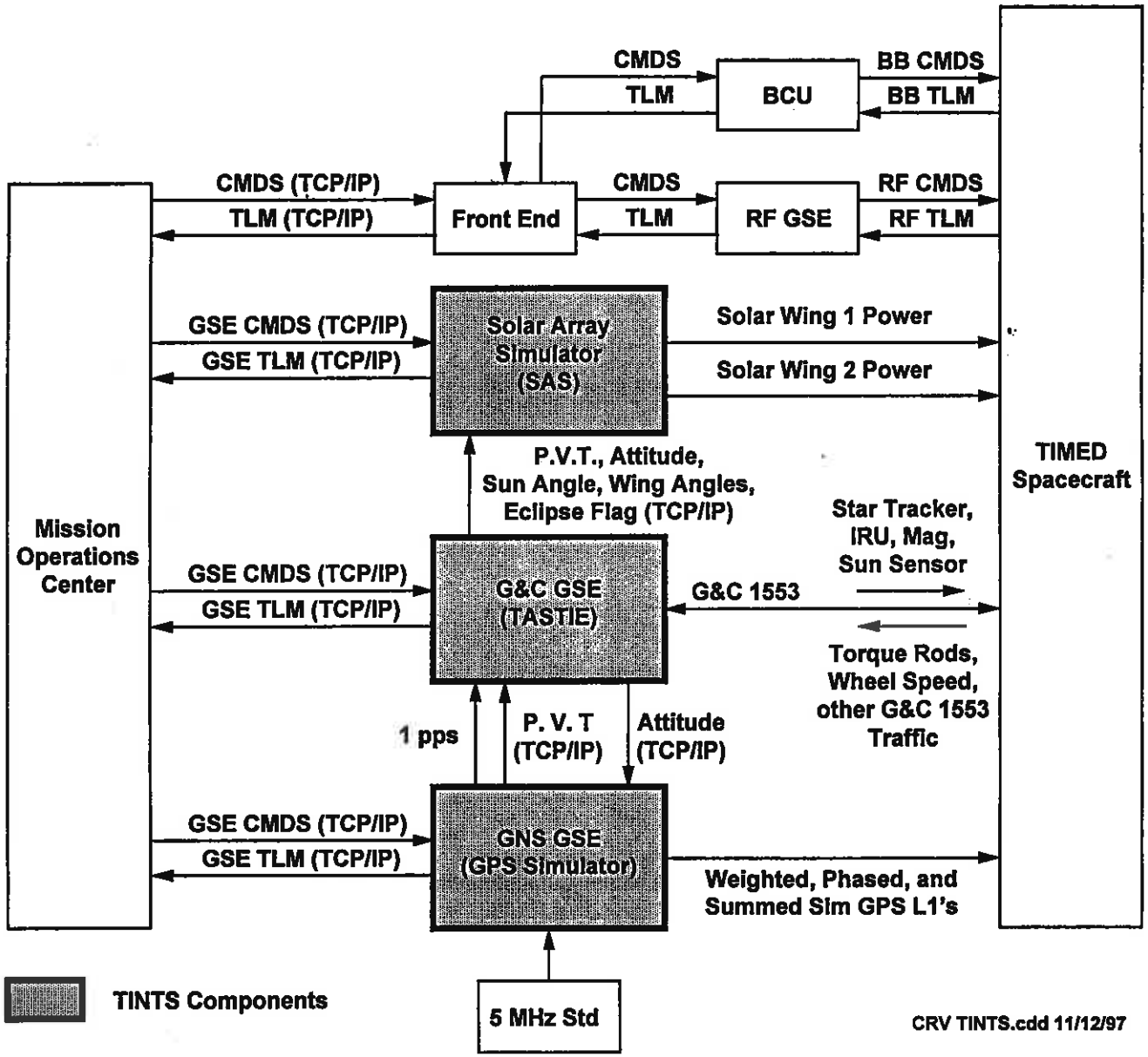
TINTS shall perform the following pre-launch:

1. Support spacecraft functional tests.
2. Support baseline spacecraft performance tests.
3. Support environmental qualification.
4. Validate and test flight software and software upgrades.
5. Rehearse and test spacecraft events, esp. launch sequence, attitude capture, nadir operations, sun safe mode, and yaw maneuver.
6. Validate and test autonomous operation.
7. Validate and test contingency plans.
8. Validate the TOPS simulator.

Simulators - TINTS Concepts

- **GSE's** - The subsystem design teams will provide GSE's to stimulate all sensors and to simulate the outputs of those sensors which can't be realistically stimulated (e.g., star trackers and gyros).
- **Integration** - As each subsystem is integrated with the spacecraft, the associated GSE will be integrated with TINTS. (Compatibility check of EM IEM with G&C allows preliminary integration)
- **Instruments** - Instrument GSE's shall not be part of TINTS, however, TINTS shall operate the spacecraft consistent with the instrument test requirements, esp. in triggering the various instrument event-based autonomous actions.

TIMED INTegration Simulator (TINTS)



Simulators - Summary

TIMED will be served by two spacecraft level simulators:

- **TIMED OPerations Simulator (TOPS)** will provide for pre- and post-launch validation of operational procedures, flight software upgrades and other uses.
- **TIMED INTegration Simulator (TINTS)** will be a test bed for flight system I&T.

Both simulators will be **hardware-in-the-loop** type which take advantage of subsystem GSEs, use **MOC control and analysis** capabilities, and **operate and perform as much like TIMED on-orbit as possible.**