iMAR
GESELLSCHAFT FÜR INERTIALE MESS-,
AUTOMATISIERUNGS- UND REGELSYSTEME MBH
WWW.IMAR-NAVIGATION.DE

iIPSC-TR
Cluster of Several Two Axes Tracking Sensor Platforms of Type iIPSC-GP40

19.07.2011, rev. 4.18

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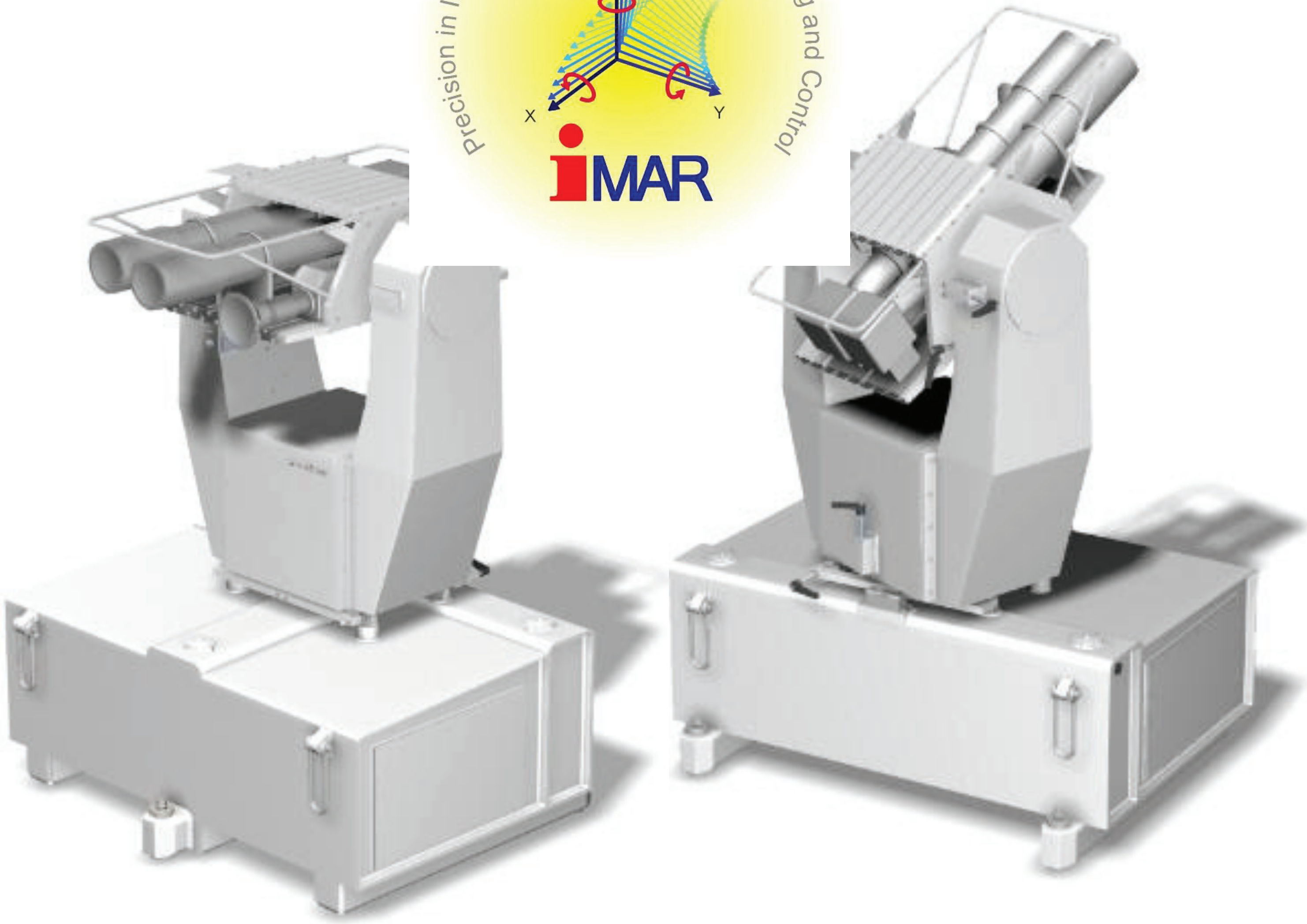
Precision in Inertial Navigation, Guidance, Surveying and Control



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Document History

Rev.	Date	Changes
1.0	05.04.2006	Initial document, helicopter testing implementation
..	..	..
4.0	08.04.10	Update taking comments from customer into account (25./28.03.2010)
4.1	19.04.10	Update taking comments from customer into account (14.04.2010)
4.2	30.04.10	Communication Protocol expanded according to Custome Requests
4.3	02.05.10	Joystick panel picture added
4.4	16.05.10	Operational Mode explained more in detail. No console but cases. (RS232-to-Ethernet) added on customer request; Block diagram extended
4.5	26.06.10	Protocol D adapted
4.6	05.08.10	Inclinometer operation and joystick panel layout detailed, software description added
4.7	27.08.10	SKIP command adapted to TVT capabilities
4.8	18.09.10	Software description updated
4.9	20.09.10	S1 switch added (INS stabilization on/off, alignment active indicator)
4.10	04.10.10	Password for software parameter protection added
4.11	05.10.10	Figure for Enslaving data processing added
4.12	12.12.10	End-stops added, maintenance of feet added, screenshots updated
4.13	03.03.11	JOYSTICK LOCK additionally used for zero adjust of joystick Delay compensation of video tracker
4.14	25.03.11	Postproc procedure added (InertialExplorer, ReadXIOFile)
4.15-I	06.05.11	Adaptation (branch) for customer Tender
4.16-I	07.05.11	Proposal for customer Tracker Range
4.17	26.06.11	Update Software with advanced Waypoint/Window control
4.18	19.07.11	Clarification according to meeting July 6th 2011

iMAR is certified EN9100 and ISO9001

TÜVRheinland® CERT ISO 9001 EN 9100

Quick Guidance through this Manual:

! Maintenance Hints are marked by a blue indicator.

! Safety Hints (Danger!) are marked by a read indicator.

! Operational Hints are marked by a green indicator.

1 Introduction

1.1 General Overview

This document provides an overview on the system configuration and performance characteristics of iIPSC-TR, a cluster of up to five Two Axes Stabilized Pedestals of Series iIPSC-GP40 with two degree of angular freedom together with the supporting devices

- TV-Tracker iOET²
- Stabilization & Control Unit iSCU with real-time operating system
- DGPS for < 1 m positioning
- Wireless data transmission between each tracker and the Central Computation Unit CCU (also called TRCC in this document).
- Shelter for CCU and for each local tracking station including air condition and operator panel.
- Trailer for each pedestal for easy transportation

Following additionally features are available as an option (not part of the main quotation; for details see section "options" in the quotation):

- RTK GPS with < 5 cm performance for fast locationing of mobile operated trackers
- Inertial Measurement System iNAV-RQH (as an option for off-shore applications, i.e. installation of the tracker on a boat).

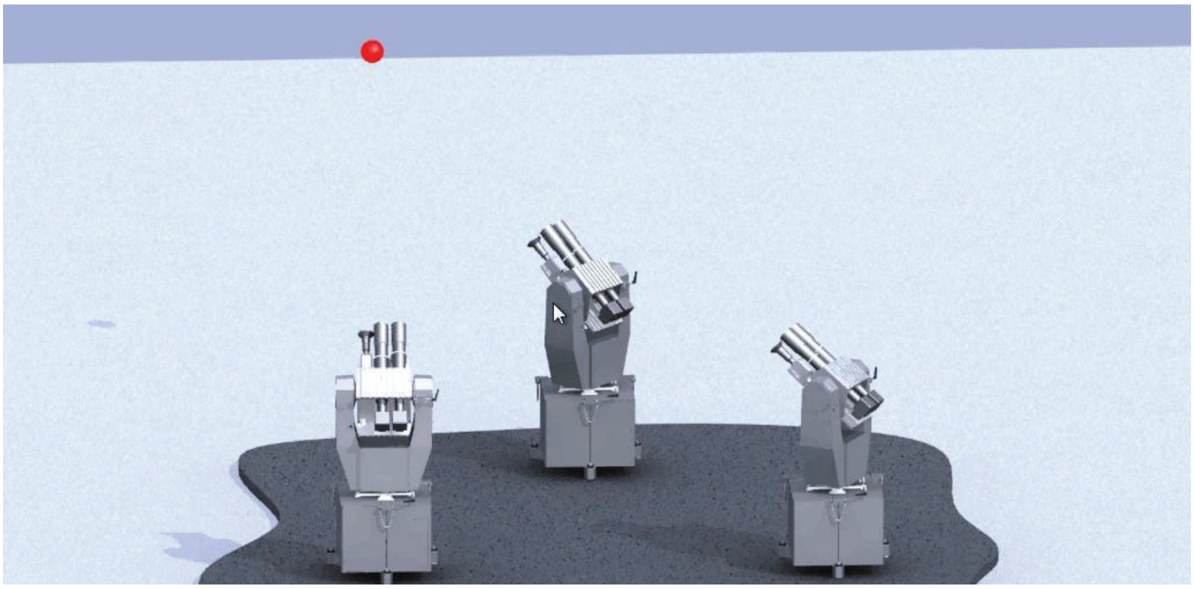

Figure 1: Tracker Range iIPSC-TR with included target trackers iIPSC-GP40

The system iIPSC-TR includes all required signal processing for real-time and post-processing for the target tracking application. Each tracker can be used as stand-alone instrument or as a device being integrated in a complex range architecture.

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Each tracker of type iIPSC-GP40 can be installed on-shore (i.e. on the beach or elsewhere on land) or – if the system is equipped with an inertial navigation system iNAV-RQH as proposed in the option – it can be operated off-shore (i.e. naval vessel installation) to increase the triangulation accuracy especially if all other trackers are installed on one straight line on the beach.

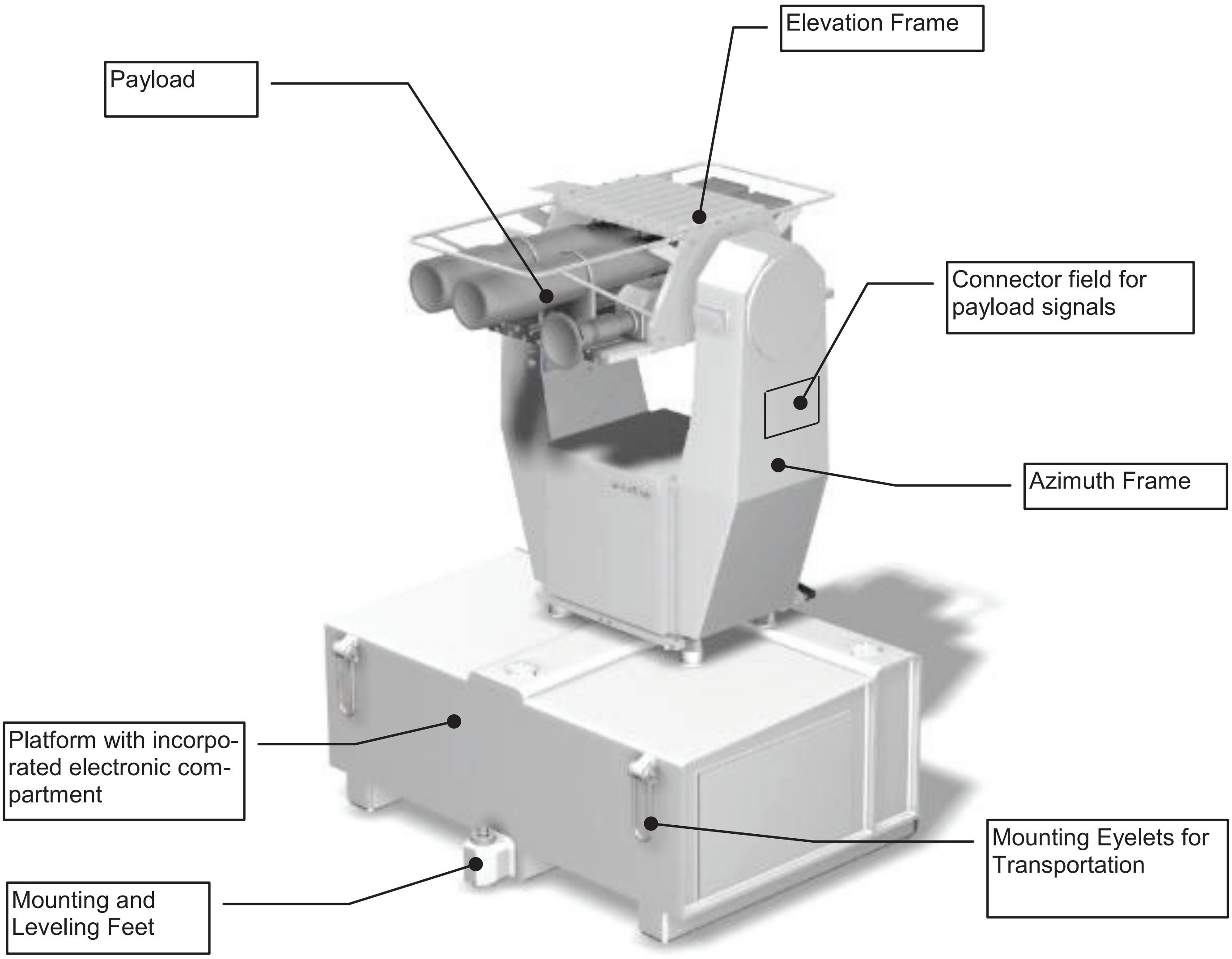

Figure 2: 3D View of the Instrument iIPSC-GP40 (version with rectangular foot)

1.2 Features Overview

- Elevation over azimuth gimbaled two axes platform with built-in control and power electronics.
- Position readout resolution better than 0.000'1 deg.
- Smooth stable rates over large dynamic range suitable for long focal length sensors
- Continuous rotation in azimuth and limited angular freedom (total travel more than 200 deg) in elevation
- Direct drive brushless torquers and direct shaft mounted optical position encoders
- High angular acceleration and rate capability to track also fast aircraft and missiles (up to more than 3 Mach at reasonable distance and target size)
- Sealed for sea coast and naval vessel environment
- Sensor Platform with central mounting of customised optical sensors. The sensor mounting platform has T-slots accepting a wide payload range. Mounting is prepared for the payload defined by customer.
- Three mounting eyelets for transportation
- Integrated iSCU Stabilization and Control Unit for remote control of the platform motion via external PC or joystick or external command interface. Available interfaces:
  - TCP/IP / UDP (Ethernet)
  - CAN Bus
- Integrated DGPS (1 m performance) or as an option RTK GPS (2 cm performance) for tracker localization

- As an option stabilization of the tracking system using an inertial measurement system iNAV-RQH (only for off-shore application, i.e. installation on a boat)

- Interfaces to be usable in automatic or half-automatic Multi-Tracker applications with up to five trackers

- Stand alone mode available with manual joy-stick control or in iOET² Opto Electronic Target Tracking mode using the analog video signal output of an onboard TV sensor (sensor to be provided by the user).

- Open user interface to allow direct drive control by the user.

Built in diagnostics, data logging capability and servo debug tools ascertains system health prior to its utilization. The controller has also build-in monitoring features during operation

- Over temperature
- Encoder watchdog
- Processor watchdog
- End switch limiters on the elevation axis

1.3 Topology Overview

The following figure shows the system architecture, as an example drawn with 3 trackers and one TRCC / CCU. Each tracker communicates by wireless data transmission with the TRCC, where the trajectory is calculated in real-time and distributed back to each tracker.

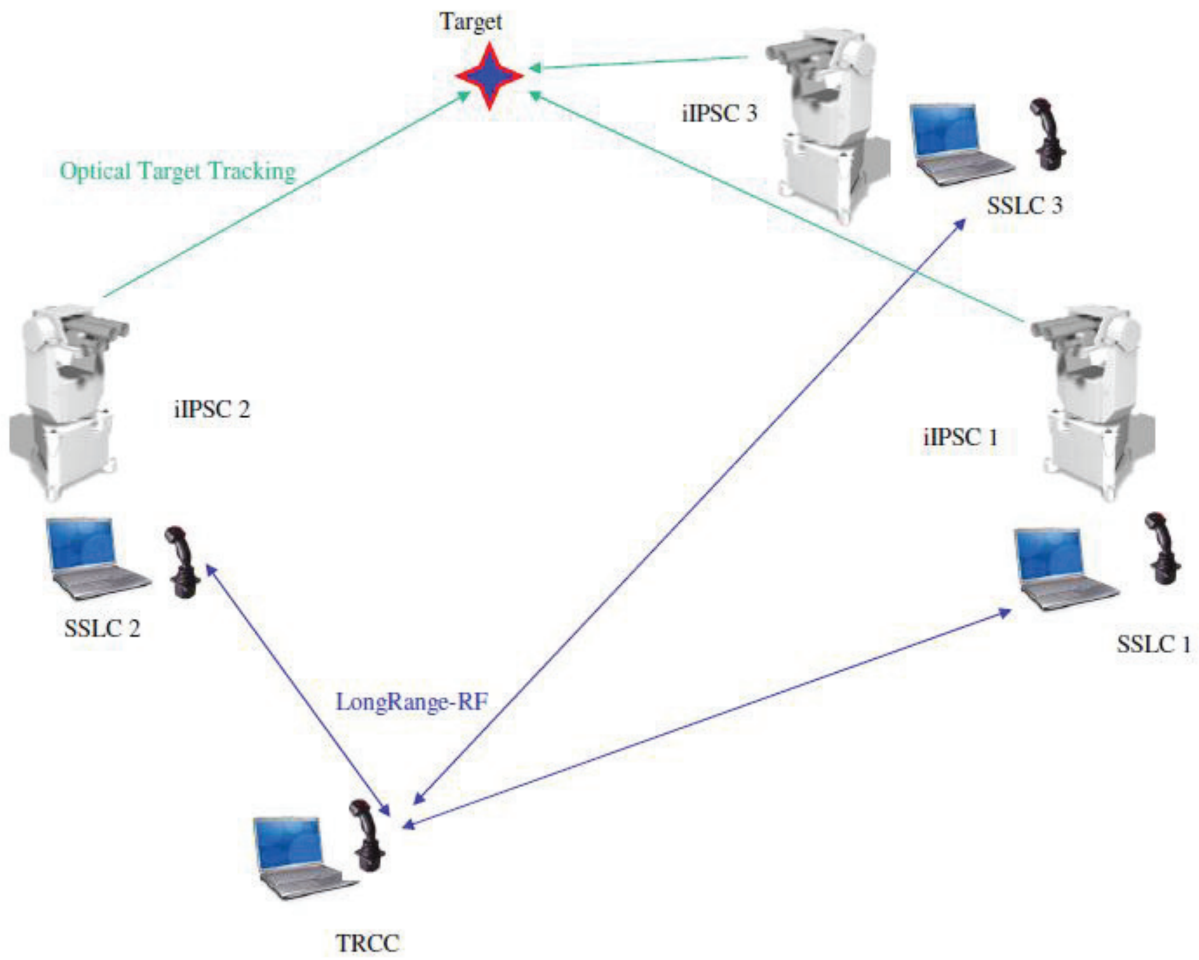

Figure 3: System architecture of N trackers, connected to one Central Station (TRCC / CCU)

The next figure shows the constellation in more detail (including INS option).

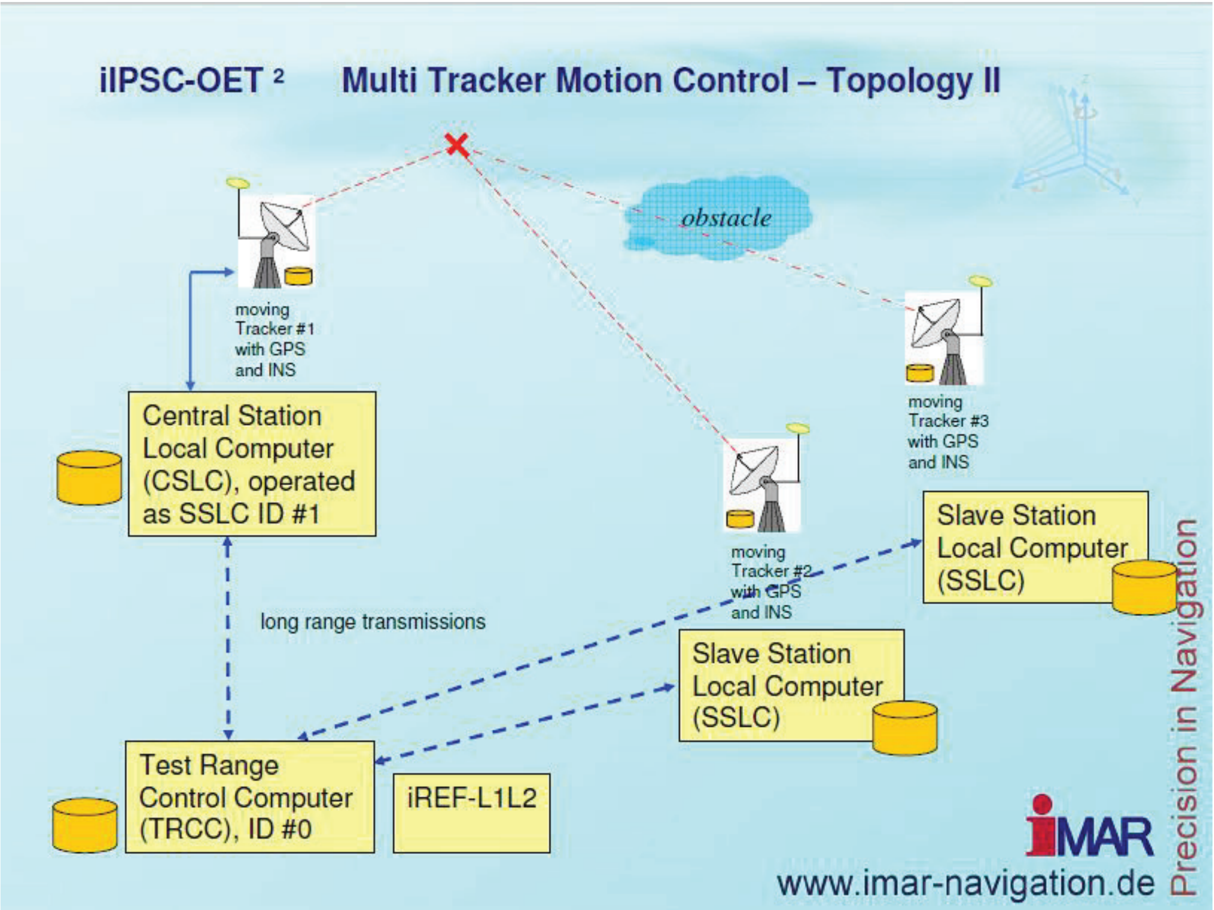

Figure 4: System architecture of N trackers (SSLC / CU), connected to one Central Station (TRCC / CCU)

1.4 Data Storage Overview

Each system generates and stores its data in real-time and provides them for analysis and post-processing:

in standard configuration:

- elevation,
- azimuth,
- time and time stamps,
- boresight errors,
- video data (time-stamped)
- triangulation results,
- GPS position,
- standard deviations,
- BIT information

and if the INS is applied as an option, additionally:

- roll,
- pitch,
- heading,
- dynamic position of the tracker [if installed on a boat])

2 Two-Axis Stabilized Multiple Sensor Platform iIPSC-GP40

2.1 Platform Design

The 2-Axis Sensor Platform employs direct drive modules for the outer azimuth axis and for the inner elevation axis. The modules support the yoke structure of the inner elevation axis with the square inner gimbal providing the mounting platforms for the different sensors. The axes are driven by brushless direct drive torquers. The high resolution optical encoder is mounted directly on the shaft eliminating any possible coupling errors.

The outer azimuth axis has unlimited angular freedom and is equipped with sliprings serving the electrical access to the payload and electrical lines of the instrument (house keeping data). The angular freedom of the elevation axis is limited. Resilient end stops restrict the angular freedom within the designed limits. Electrical limit switches monitor and protect the end stops.

The elevation axis is orthogonal to the outer axis featuring the square gimbal with the mounting platforms for the different sensors.

Manually adjustable leveling spindles permit the precise vertical alignment of the azimuth axis. Concentric anchoring bolts secure the instrument to the foundation and lock the leveling adjustment. There is no undue stress introduced assuring good long-term stability.

The Cross Spirit Level simultaneously visualizes the inclination of two axes in the base of the device. This enables a quick coarse leveling of a tracking mount. The resolution of the spirit level matches the range of the precise inclinometer mounted in the yoke structure of the azimuth axis.

For stationary applications, the instrument is mounted on a ruggedized compartment which is hosting the electronics and the INS. Manually adjustable leveling spindles permit the precise vertical alignment of the azimuth axis.

2.2 Servo Loop for Drive Control

Both torque drive axes have the same basic drive system. Figure 5 outlines the different modules of the all-digital speed/torque controller. Designed for direct drive application, the controller uses the position information of a high-resolution optical encoder to generate the sinusoidal commutation current. The optical encoder provides a pseudo-absolute output for initialization and continues operation as a relative encoder device with SIN/COS advanced resolution generation.

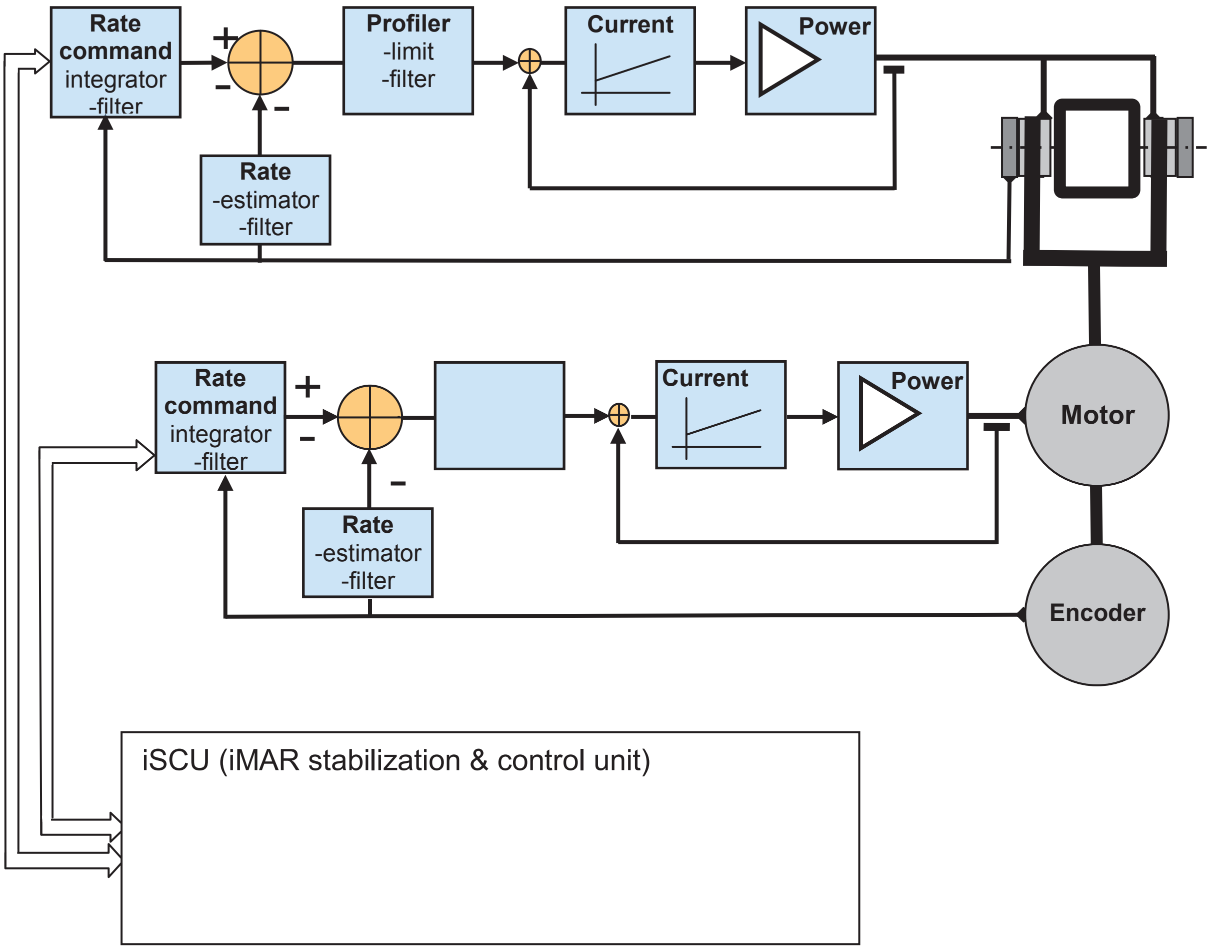

Figure 5: Torque Drive Control Design (iMAR controller)

There are two regulation loops, a **position loop** and a **current loop**. The current loop generates the signals for the power bridge with respect to the position of the magnetic motor poles. The brushless motors are getting sinusoidal commutated. The command is rate / torque related.

2.3 Sensor Mounting Surfaces

The central square elevation gimbal has four mounting surfaces for the payload. T-slots allow the mounting of the sensor at the suitable longitude position for best balancing about the elevation axis. The large sensor mounting platforms provide also space for the mounting of counter balancing weights.

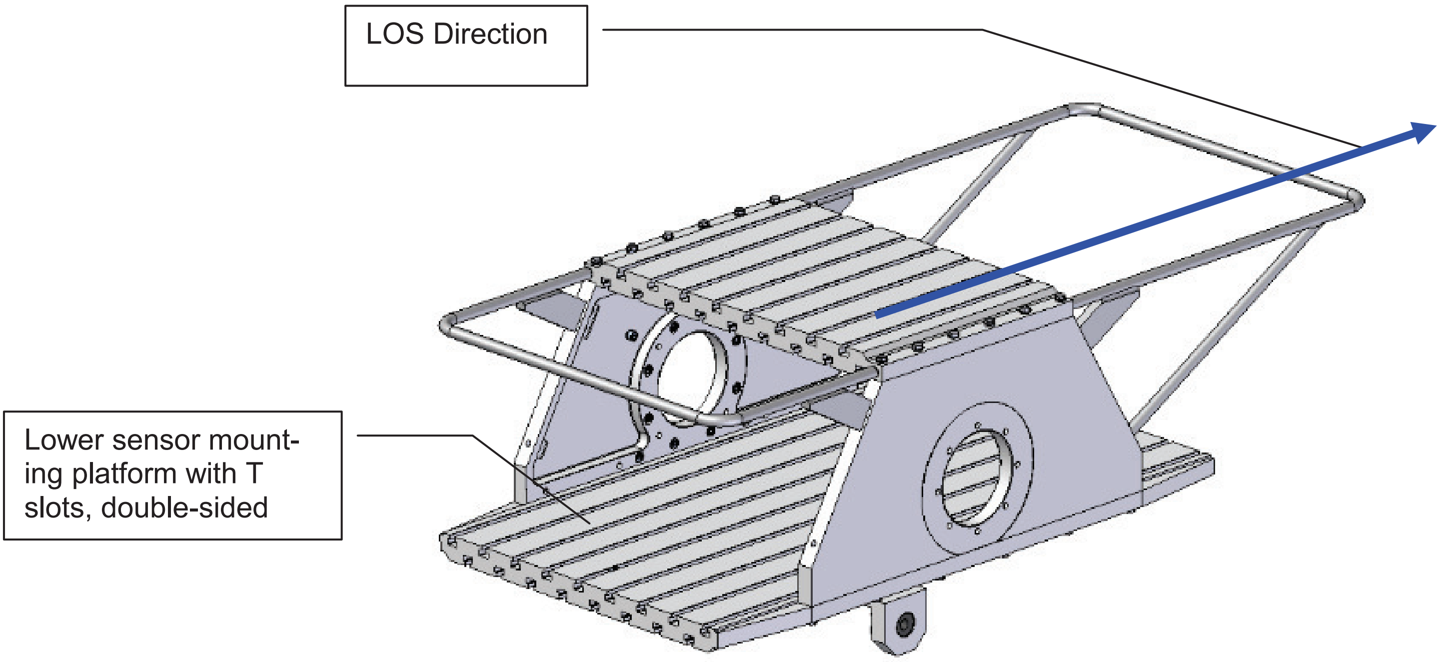

Figure 6: Sensor Mounting Surface

2.4 Payload

The sensor systems (e.g. cameras) are are mounted on the sensor mounting surface. The payload is balanced for best dynamic and static tracker operation and lowest power consumption.

The Sensor Mounting Surface is specially designed for the customer's payload requirements.

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Warning:
The payload may be supplied by 235 V AC. Switch off any power supply and disconnect any cable to the system prior opening the cable tray covers or performing any work on the payload.