The Cube Analyst Suite is comprised of two separate modules:

- CUBE ANALYST Drive
- CUBE ANALYST

These programs are important tools for estimating static and dynamic roadway and static public transport origin-destination matrices. These matrices can be used directly in traffic assignments in Cube Voyager or in dynamic traffic assignments in Cube Avenue or serve as a base for which to estimate the future level and distribution of travel.

Cube Analyst Drive uses data assimilation techniques to estimate and optimize static and dynamic roadway trip matrices. With Cube Analyst Drive, modelers can use packet log files produced by Cube Avenue dynamic traffic assignments to estimate time segmented origin-destination matrices. With advanced parallel capabilities, Cube Analyst Drive can tackle the largest static and dynamic estimation problems with ease.

Cube Analyst provides users with a way to generate statistically optimized static origin-destination matrices with data generated from a wide array of Cube programs including the legacy TRIPS programs. Users who wish to estimate public transit trip matrices, or who wish to use static turning counts or partial trip matrices in their estimation of roadway matrices should use Cube Analyst.

The Cube Analyst Suite can elevate unrefined base matrices to a new level of accuracy through complex mathematical techniques that allow the input origin-destination matrix to match other input data in the best manner possible.

**Matrix estimation with Cube Analyst Drive**

Data Assimilated Matrix Estimation Features available in Cube Analyst Drive include:

- Dynamic Matrix Estimation
- Multi-Class Static Estimation
- Estimation of Very Large Static Matrices
- Parallel execution suited for high performance clusters and Cube Cloud

**Modello and numerical method**

A cost function is defined and minimized through numerical methods producing the optimal matrix, which fits the given input data and estimation parameters. In general, the cost function developed in Cube Analyst Drive seeks to minimize the distance between the simulated volume and the observed traffic counts while maintaining the basic structure of the input OD matrix. Other factors may be taken into the cost function calculation depending on the specific application such as trip end data or count confidences.

The minimization of the cost function is carried out by the conjugate gradient method for optimization. The algorithm uses fast sparse matrix routines and a quadratic minimization sub problem to determine the optimal search step length, producing a fast and efficient optimizer. Cube Analyst Drive employs parallel computing techniques at various levels including multi-threading for multi-core processors and message passing for distributed computer clusters.

**CUBE ANALYST Drive or Cube Analyst?**

Both modules are included within the Cube Analyst Suite. In general, when estimating roadway matrices, Cube Analyst Drive provides the best solution. It is much faster and can handle very large problem sizes (for example, 7000 zones, 9 user classes using 10,000 screenlines) and can estimate both static and dynamic matrices. When estimating public transport matrices or estimating static roadway trip matrices using static turning counts, use Cube Analyst.
Program Input and Output

INPUTS
Cube Analyst Drive accepts various data inputs and parameters for use in the estimation process, and varies depending on the type of estimation being performed (static or dynamic).

**Static Estimation**
- Static OD matrices with or without confidence levels
- Highway generated ICP files
- Highway generated screenline count files
- Static trip end files
- Static model adjustment parameters

**Dynamic Estimation**
- Dynamic time-segmented OD matrices
- Cube Avenue packet log files
- Dynamic screenline count files
- Dynamic turning count files
- General format files for route choice and OD matrices
- Dynamic Model adjustment parameters

OUTPUTS
Cube Analyst Drive provides the user with an updated trip matrix that best matches the input data and parameters. In addition, a report file is generated which contains valuable information about the estimation results for individual counts and aggregated count statistics data.

Matrix estimation with Cube Analyst
Cube Analyst uses maximum likelihood techniques to find trip tables that are consistent with observed transport demand and count data. Typical data provided to Cube Analyst:
- Trip end data, such as a survey at a shopping center
- Traffic counts, organized into screen-and cut-lines
- Movement or path data identifying the routes used by travelers developed by Cube Voyager, TP+ or TRIPS

In addition, and a key element in Cube Analyst, the user provides quality weights. These provide tolerance bands to each of the individual or groups of data observations. Cube Analyst uses maximum likelihood statistical techniques to estimate the cell values for the matrix. These values are those that fit the best with the observations and their quality weights.

Key advantages of Cube Analyst
Exploits a wide range of low cost, readily available data:
- Existing trip matrices, either from surveys or from travel demand models
- Flow counts from all types of counting devices
- Trip end data from parking surveys
- Public transit data from boarding and alighting surveys
- Partial trip data from license plate and other cordon surveys
- Electronic ticket data

Rigorous methodology
- Cube Analyst uses the maximum likelihood statistical method
- A powerful optimizer allows individual cells to be estimated with precision
- The calculation is self-calibrating

Integral quality assurance
- Extensive reporting options
- Effects and implications on the estimated matrix of different input data may be studied
- Specialist tools indicate the quality of the estimated matrix
- Quality analysis of estimated matrix guides data collection efforts

Cube Analyst Methodology

**Stage One: data preparation**
The type and quantity of data input to the estimation process is left to the user to determine. As a rule, the more data provided, the more accurate the resulting estimated matrix will be, but it is possible to achieve worthwhile results with limited data.

Data used by the estimation can come from several sources, including:
- Existing trip matrices, either whole or from a sector of the study area
- Traffic count data obtained manually or from automatic counters
- Trip end data obtained from parking surveys or from trip generation equations
- Partial matrix data from cordon surveys
- Boarding and alighting trip surveys for public transit
- Routing data, calculated by Cube Voyager, TP+ or TRIPS
Stage Two: data variability
A distinctive feature of Cube Analyst is the treatment of the inherent variability of transport data as an integral part of matrix estimation. The variability in the quality of the data is handled using confidence levels. Confidence levels are set for each observation or for each group of observations. Cube Analyst facilities help users to judge the effect of altered quality and confidence levels on the estimated matrix.

Stage Three: estimation
The matrix is estimated by the software. This is a computationally intensive phase, but requires minimal attention from the user. Cube Analyst performs a set of iterative calculations which will automatically determine the statistically most likely matrix for the set of input data values provided. The first time Cube Analyst is run, it creates a set of files which can be used to reduce the run times of subsequent runs of Cube Analyst. This ability to benefit from a previous run of Cube Analyst is usually used to assist in analyzing the consequences of changes in data values.

Stage Four: quality assessment
The approach to analyzing the quality of the estimated matrix is:
- Comparing the estimated results with input data values
- Checking the sensitivity of the results if data values are altered
- Analyzing the estimation calculations

Besides information output by Cube Analyst itself, extensive use is made of other Cube programs for creating tabulations and graphic displays which highlight different characteristics of the estimated matrix. Information comparing input data with corresponding values derived from the estimated matrix are readily accessible. A number of facilities characterize the extent of changes and help focus attention on areas of significant change between input and estimated information. These capabilities are especially valuable for large matrices.

Stage Five: improving the matrix
Deficiencies in the quality of the estimated matrix, when they are signaled by the results of the analysis phase, are remedied by improving the quality or quantity, or both, of the input data. The analysis phase can provide strong pointers as to which data are contributing to quality problems and hence where the user can focus attention.