TOPIC #4 :

Building Traffic …
for RT/FT simulations

Overview

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Presentation overview

- Warm-up :
  « On an example: a large scale TMA/EnRoute experiment »
- Building the traffic
  - A proposed generic process
  - Review of the tools/techniques
- A discussion : simulator models
- Appendix:
  - References

A foreword

- A lot of technical documentation available on simulators :
  - User’s guide
  - Performance
  - Model
  - …
- Some documents on how a dedicated set of traffic samples have been built for a project
- Very few documents addressing « How to build efficientlyTraffic samples »
- … perceived as a set of « cook’s recipes » …

The setting

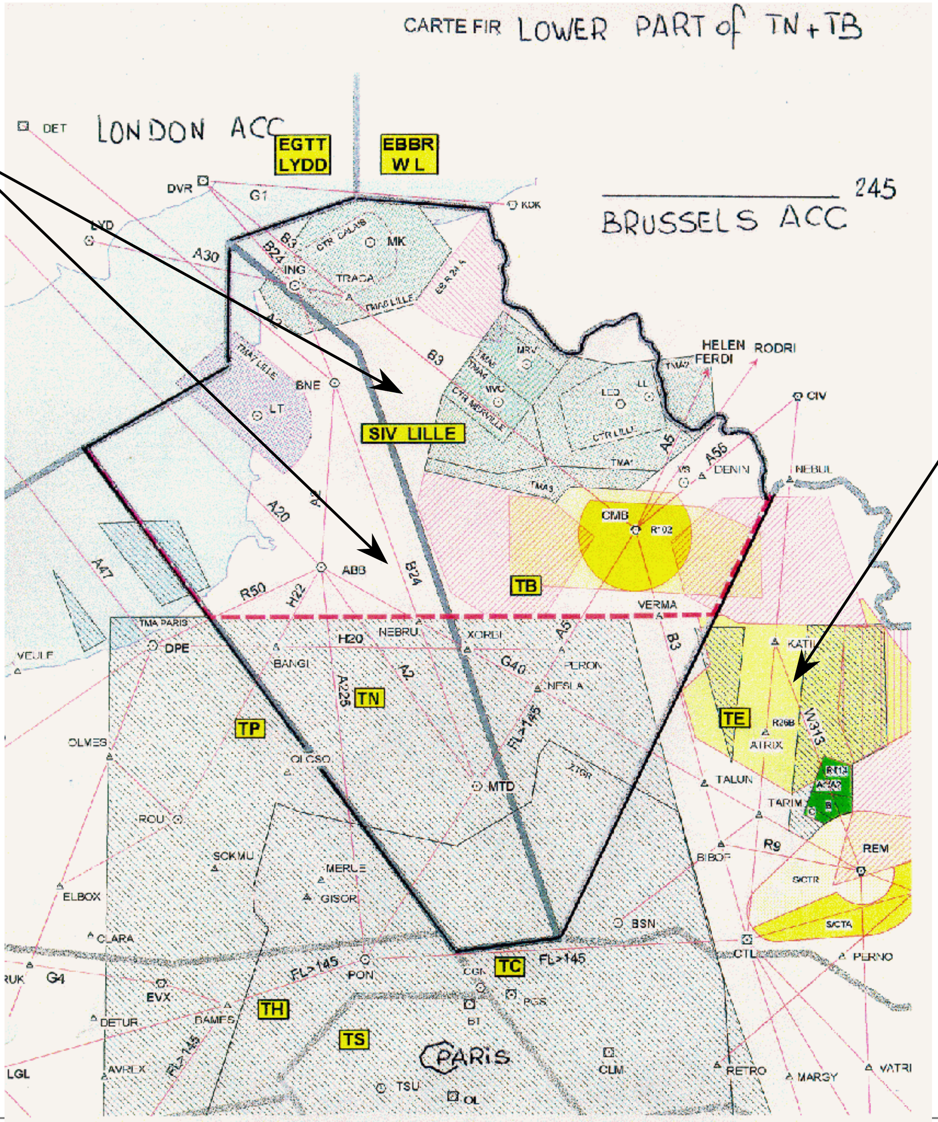
Objectives

- A large experiment targetting evaluation of 4D trajectory negotiation, Departure Manager concept, PHARE Advanced ToolS
- A sophisticated validation environment:
  - DAARWIN platform :
  - MASS : a realistic Multi-Aircraft simulator using MASK model: « Model with Aircraft Simplified Kinematics, based on a total energy model »
- A real airspace to model :
  - PD3 measured sectors : 3 of them ;
    - one upper sector, UN/XN from 245 till unlimited, situated in REIMS ACC
    - one FIR sector, TN/TB from 55 to 245, in PARIS ACC
    - PARIS TMA volume below with different airports:
      - » Charles De GAULLE LFPG, Paris ORLY LFPO, Paris Le BOUGET LFPB, Paris VILLACOUBLAY LFPV, TOUSSUS Le NOBLE LFPN
  - PD3 feeder sectors
    - two upper sectors, UR/UY and UZ/ZU, situated in REIMS ACC
    - one FIR sector, TE, in PARIS ACC.

The setting

- SECTORISATION TN/TB

Measured sect:TN/TB



Feeder sect: TE

On an example: a large scale TMA/EnRoute experiment

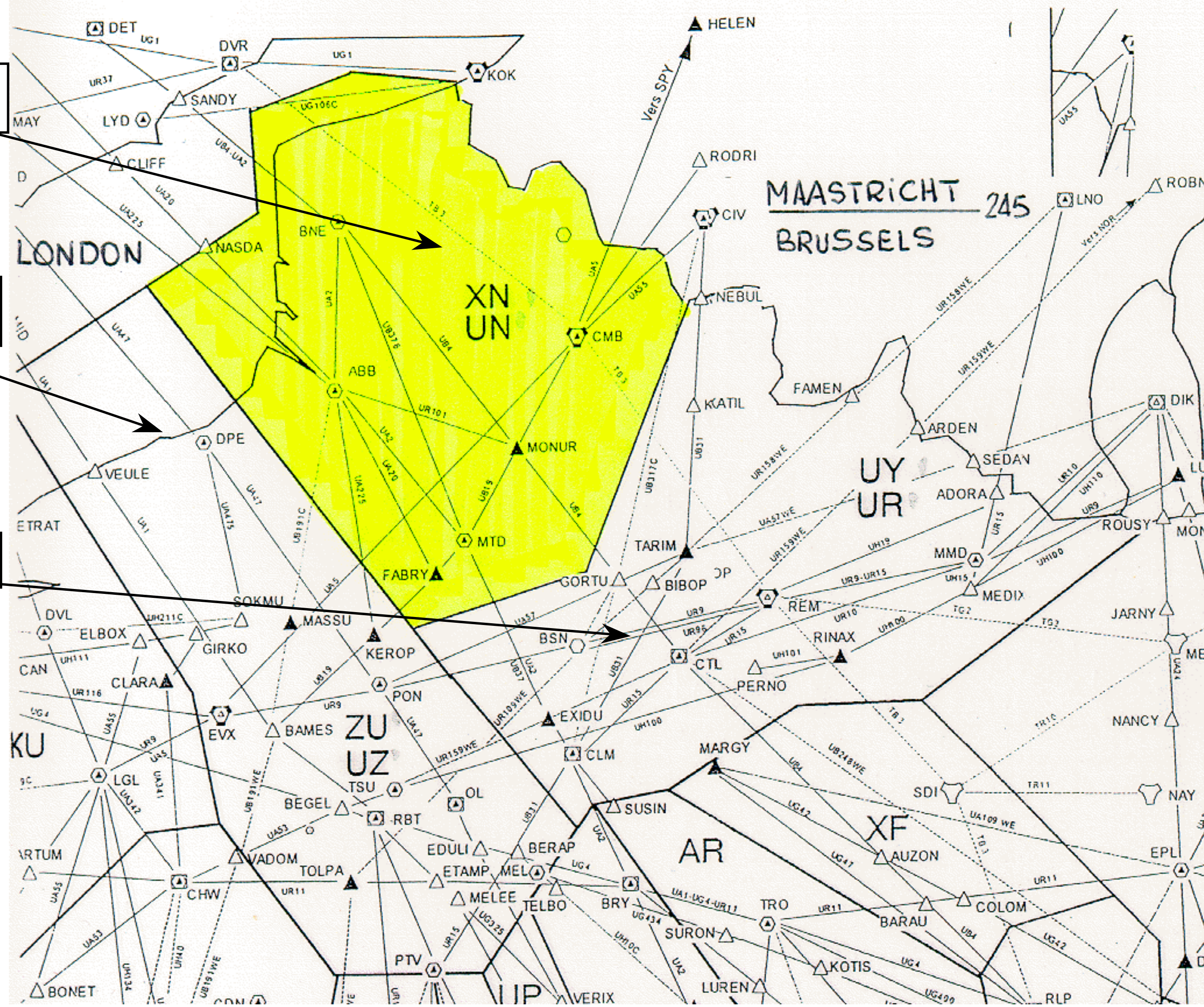
The setting

- SECTORISATION UN/XN from 245/ unlimited

Measured Sect: UN/XN

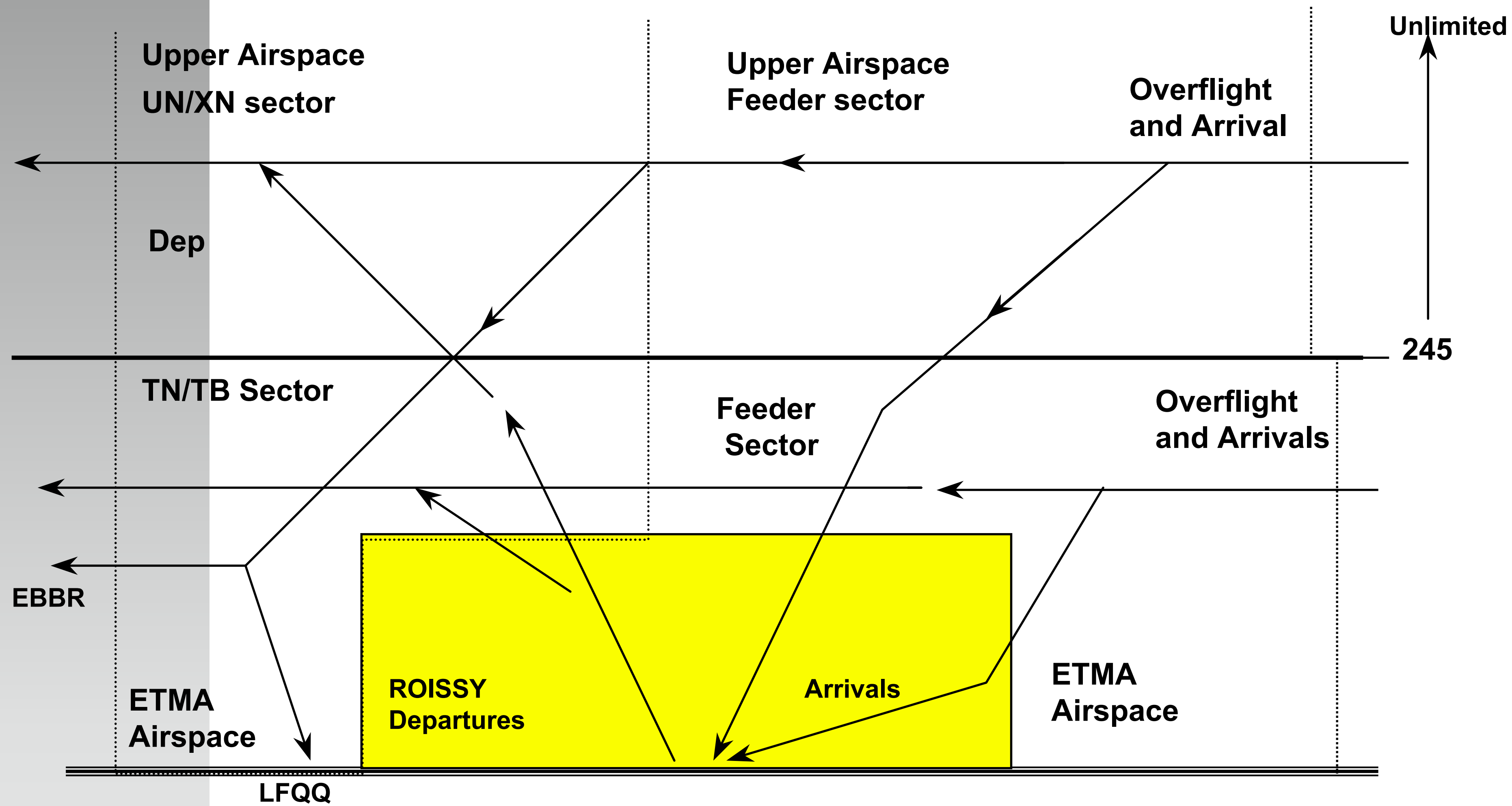
Feeder Sect: UZ/ZU

Feeder Sect: UR/UY



The setting

- A simplified vertical view of PD3 sectors



The requirements

- A reference date :
  - Friday 21 th june 1996 - summer peak. Since this date, widely overtaken.
  - SOME VALUES
    - Realised Flight Plans over France = 6405
    - Ch de Gaulle Airp Mvts with 2 RWY = 1084
- What was available in june 1996?
  - UN/XN = 37 UR/UY = 42 UZ/ZU = 45
  - TN/TB = 30 TE = 28
  - Charles De Gaulle Airp = 80/85 increasing with only two RWY
- What is expected in PD3 future
  - horizon 2005 = 1996 rate x 1.5
  - horizon 2015 = 1996 rate x 2.25
- Objectives : building 2 x 3 traffic samples , to be made up in order to represent 3 catagories of fleet (different DL and nav. Equipment levels) + 4 training samples = 10 traffic samples

The process

- Building environmental data :
  - Sectors, PDR, Waypoints, Letters Of Agreement (specifying the exchange conditions between two adjacent sectors)
  - SID(s) and STAR(s) for TMA Airports
    - Huge efforts although just one configuration (Orly and Roissy facing Ouest)
- Selecting live samples
  - EXTRACTION OF FLIGHT PLANS
    - Data Base: 21st of June 1996
    - The best time slots to get most significant FPL for the PD3 sectors configuration
    - Available Mvts on UN/XN + TN/TB + TMA Airp = 3329
    - " " " feeder sectors = 2146

Major difficulties

- A global analysis of each traffic sample is not easy:
  - Too much Ac with overlapping,
  - Size of the screen to present the situation,
  - Multiple interactions between crusing and descending or climbing Ac.
  - Solution:
    - Data processing, layer by layer, in upper and lower sectors,
    - Particular data processing traffic flows,
    - Adjust the different kinds of problems.
- Environmental data : SID(s) and STAR(s) for TMA Airports
  - Data processing description to be played
    - Just one configuration: Facing OUEST in accordance with space model.
    - Validation
- Resolve the problem with arriving flights
  - In PD3, only the DEPARTURE position is played with a new concept of Departure Manager tool ; to work properly, the DM needs arrival flights ;
  - In PD3 no simulated position is expected to manage and regulate the arriving flights ;
  - In TMA, and only for Ch De Gaulle Airp, the RWY(s) are feeded by 3 IAF : MERUE, SUSIN, BSN ;
  - Solution:
    - Creating a special arrival sequence as if arrival flights were controlled from the TOD until landing.

Limitations

- The rate increase of traffic will be modulated according the size of proposed radar display and number of ATCO working on position.
  - Size of screens are different between measured and feeder.
- The traffic out of measured sectors will not be shown.
  - That concerns traffic exchanges feeder to feeder
- On feeder positions the number of problems will be reduced as far as possible.
  - just one controler
- The rate of increase for Ch De Gaulle Airp is difficult to appreciate because the space model (june 1996) can use only 2 RWY(s);
- But through our Heavy Traffic Sample we'll try to increase departures so to explore the benefits of the Departure Manager
- Arrival flights
  - They are on autopilot, flying on specified STAR and APP for an automatic landing;
  - Requested ATCOs' behaviour :
    - For each fligth, you could see in the corresponding radar label the name of an IAF an the value of the transfert flight level.
    - Remember:
      - **MERUE => 110**
      - **SUSIN => 80 or 60**
      - **BSN, or X01, or X02, => 80 or 60**
    - « Never try to control these AC. Arrival sequence will be in this case partly destroyed »

Cost / ROI

- Cost
  - 8-10 Man x Month
- Return Of Investment
  - Only one series of 2 experiments have been run on these data
  - As they are, data were considered obsolete just 1 year after the experiment:
    - CDG set a 3rd then 4th specialized runway
    - Paris TMA has changed its set of SID/STAR/Approach
  - Conclusion:
    - Exceptional endeavour which can not be reproduced on a regular basis
    - Looking for clue to speed-up the process, be more reactive, adaptative

The process

Setting key elements

- Type of Simulation
  - FT/RT
- Type of simulator
- Target airspace
  - Type
  - Nature

Building env.data

- AC, vehicles performances record
- Waypoints, Routes (PDR),
- Sectors, Letters Of Agreement
- SID, STAR, APP, Runway, Hold, Go-Around, Oc.tracks, …

Validation

Building initial traffic description

- Identifying key hours when to find relevant samples
- Extracting, gathering set of relevant samples (most often from real world)
- Enlarging the set of FP (preparing growing phase)

Tuning traffic samples

- Growing method
- Setting management policy of env.ac
- Setting management policy of target ac / ac equipment
- Building events : conflicts, other interesting situation
- Planning scripting events

Validation

Delivering traffic samples

- Optional : facilitating make up of sample = « brotherhood samples » ; making difference on a/c equipment

Tools/techniques (my choice)

Setting key elements	*Building env.data*	*Building initial traffic description*	*Tuning traffic samples*	*Delivering traffic samples*
← Having a good understanding of validation objectives, level of maturity of the concept,… ← Take in account stakeholders' wishes (target airspace) ← Having a good understanding of the requirements of each simulator	← Validated ac performances DB : BADA DB, ← AIS system records, ← Op.Req. Document (MANEX)	← Record of real world: TACT, IDPS (COURAGE/ SHAMAN) ← Forecast prediction tools (Eurocontrol)	← Testing tools : light version of the target simulator (MASSCOT/ MASSPLOT) ← What-if tools ; capability to move in time a FP quickly ← Influence of ac nav equipment ???	← A question of File/Data management ← Build automatic tools to manipulate « brotherhood samples »

Best practices (suggestions)

Setting key elements	*Building env.data*	*Building initial traffic description*	*Tuning traffic samples*	*Delivering traffic samples*
Have a good understanding of the cost of use of a simulator Propose the right tools for the task Let aware SH of generic airspace possibilities	Hire operational people to prepare these data If not possible hire operational people to validate these data Validate a/c performances	Be in touch with real world Get expertise from the field	Have a good knowledge of op.limitations which can not be overtaken without serious op.change/hypothesis Choose the right tool to reduce loop duration Test/test/test as often as you can hire operational people to validate the result	Organise data samples, log file as a whole Establish good dependency rules Establish a test procedure (CRC, PGP signature)

A discussion : simulator models

bridging the gap between FT and realistic RT ??

	Generic airspace	Airspace based on reality
« physical model » - total energy - …	- - amount of data required, accuracy, time for validation - ac, vehicles performances record - expertise to design procedure (but only once) + quality / effort (possibility to tune endlessly) + lifetime should increase - lack of reference ++ usability	- - amount of data required, accuracy, time for validation - ac, vehicles performances record + rely on field expertise - quality / effort - - short lifetime of samples + reference exists +
« heuristic model »	Counterproductive :-(	++ behaviour of existing ac, vehicles; ++ far less effort required to build env.data, performances of ac, vehicles + introduction of « real world noise » - dynamic behaviour of ac, vehicles ++ quality / effort

Appendix :
References

- A list of relevant points extracted from « Best Practices »
  - §2.4 Choosing a simulator and assessing fidelities
    - Fidelity-cost trade-off analysis
  - bp 11. Document those areas where the experiment needs high fidelity to the real world
    - « Not every aspect of a simulation needs to be of the highest fidelity. Cost and other factors often limit the level of simulation fidelity. However, it is not necessary to achieve the highest fidelity in every respect in order to relate the results to the real world. Careful consideration should be taken to ensure the level of fidelity is appropriate for each major area of the study. »
  - §4.3 Airspace and scenario development considerations
    - bp 15 Be open-minded. Consider unconventional options such as “generic airspace”.
    - bp 16 Research questions should drive scenario development.
    - bp 17 Identify and maintain common scenario characteristics for comparison.
    - bp 18 Starting and/or ending scenarios slowly is not usually efficient.
    - bp 19 Define and maintain necessary levels of realism.
    - bp 20 Traffic peaks and troughs may be relevant to research.
  - bp 21 Do not sacrifice simulation quality for the interest of time.
- Other references:
  - Simulator Fidelity - Industrial and Occupational ergonomics : Encyclopedia, 1999 - International Journal of Industrial Engineering - Parimal Kopardekar
  - Simulation Interoperability Standards Organization http://www.sisostds.org/
  - Rejeu software : web page available on CENA/Toulouse web site http://www.tls.cena.fr/divisions/PII

Appendix:
Initial scope

- Topic 4: Building Traffic
  - Scheduling
  - Current
  - Future (Forecasting)
- Range of Loading (High Traffic/Low Traffic)
- Fleet Mix (Future Aircraft types)
- Generic Traffic Samples
- Proprietary Airline Data
  - Business Cases (Hub & Spoke vs. Point to Point)
- Aircraft Characteristics
  - Performance
  - Load Factor – Passenger
  - Weight of aircraft
  - Avionics
- Validation

Empty form

Setting key elements	Building env.data	Building initial traffic description	Tuning traffic samples	Delivering traffic samples